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CAPITAL INVESTMENT DECISIONS WITH MANAGERIAL OVERCONFIDENCE AND REGRET AVERSION

Christopher Philipp Klauss

A thesis submitted for the degree of Doctor of Philosophy

University of Bath
School of Management
May 2006

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Abstract

This research investigated the potential effects of managerial overconfidence and regret aversion in a corporate capital investment context. Three fundamental decision problems are analysed: Project selection (accepting or rejecting a proposed investment), managerial effort, and project evaluation (continuing or abandoning a failing investment). Very little previous research has looked at the role of psychological biases in corporate finance decisions, and the joint analysis of the two studied biases within one model is also a fairly novel contribution.

Solving by backward induction a theoretically derived model integrating these decisions as well as overconfidence and regret aversion, I outline the conditions under which a biased manager will make choices that are inefficient from a shareholder value perspective; however, the model also reveals that, in combination, the two psychological phenomena may off-set such that the optimal outcome can be obtained.

I further demonstrate how my theoretical propositions can be supplemented with empirical data by means of a survey and two different experiments. The survey of UK managers with capital investment responsibility exposes the pervasiveness of overconfidence and regret aversion within the sample group. In addition, indications for potential associations between these biases and certain capital investment decision choices are found. To my knowledge, no such empirical study exists so far.

To explore potential causal relationships between overconfidence and effort, overconfidence and project selection, as well as regret aversion and project evaluation choices, two experiments were designed and conducted. The experimental data provides tentative support for the model and indicates the potential value of larger-scale future research.

I close by discussing the implications of my results for corporate governance and suggesting avenues for future work in this area.

INTRODUCTION

Companies can invest money in physical, financial or intangible assets (Seitz & Ellison, 2004:14). In this research, I focus on investments in physical assets. Such capital investments have the purpose of achieving and sustaining a competitive advantage, which is essential to making profits; in turn, the generation of value by making profits is the reason why companies exist because shareholders will only provide equity to fund enterprises that pursue growth in value. In general terms, any form of corporate investment should thus be driven by the expectation that the "future flow of satisfactions [...] when appropriately discounted [...] will [...] exceed the satisfaction presently obtainable" (Smith, 1971:69). However, since human beings lack complete foresight, the future and hence investment decisions are clouded by uncertainty.

Research in Psychology has shown that human decision making under uncertainty may be influenced by several cognitive and emotional factors. The potential relevance of these phenomena for research in finance was first recognized by only a limited number of academics about 25 years ago. For a long time, their work has been somewhat marginalised as allegedly being concerned only with rare anomalies in the functioning of the human brain. The main reason why this young discipline encountered relatively strong opposition was that the core of its propositions seemed irreconcilable with the foundations of the existing financial theory. In particular, the claim that stock market investors could have systematically biased expectations was heavily criticised by the more established scholars in this field.

Under the dominant paradigm in Finance, investors are assumed to be instrumentally rational and hence free of any systematic bias. Any less-than-rational individuals would be driven out of the market by the rational investors taking advantage of their biased expectations. This process of arbitrage was hence seen as a guarantee for efficient markets in which nothing but fully rational behaviour could persist. In spite of research showing that there may be limits to full arbitrage (Shleifer & Vishny, 1997) and the famous remark by Alan Greenspan (1996), former Chairman of the US Federal Reserve Board, that stock market valuations were at the time driven by "irrational exuberance", the idea that psychological factors could have anything more than a

short-term effect on stock prices is still met with considerable scepticism by most academics in Finance.

However, irrespective of whether one believes that stock markets are efficient or not, an area where the forces of arbitrage are very likely to be limited for several reasons is within corporations (Heaton, 2002). Consequently, the capital investment decisions of individual managers should be even more likely to be subject to psychological biases than those of market investors; in particular, since capital investments are characterised by uncertainty just like stock investments. Surprisingly though, most of the existing literature on the role of psychological phenomena in financial decisions has focused on stock market related topics, with issues of corporate finance having been neglected. A general aim of my research is thus to contribute to this largely deficient body of knowledge.

Specifically, I concentrate on three (consecutive) decision problems of the capital investment decision process: Selection of an investment, managerial effort level choice, and evaluation of an ongoing investment. Within this framework, I investigate theoretically and empirically the role of two robust and well-documented psychological phenomena, overconfidence and aversion to regret. Adopting a shareholder-value perspective, I seek to find out how managerial overconfidence and regret aversion might affect decision behaviour at each of the three capital investment decision problems. In doing so, my research will address the following questions:

- What characterises overconfidence and regret aversion?
- Which predictions for the behavioural effects of overconfidence and regret aversion can be made for the chosen capital investment decision framework?
- Is either of the two biases relevant in the chosen context? Hence, are managers who make capital investment decisions affected by overconfidence or regret aversion?
- Can the predicted behaviour be observed in practice?
- Is there empirical support for the hypothesized behavioural effects?
- Are the predicted effects good or bad with regard to shareholder value?
- What are the implications of this research?

My analysis will relate to individual rather than group decision-making, and also ignore any other organizational aspects that may in reality affect corporate investment. A further delimitation is that I consider the effects of overconfidence and regret

aversion exclusively. Given the importance of corporate capital investment for companies but also for the economy as a whole, it would seem a worthwhile pursuit to gain a better insight into how the individual managers in charge make these decisions. My research adds to the literature by proposing a formal model of the identified capital investment decisions, from which testable predictions on the effects of overconfidence and regret aversion are derived, and empirically evaluated. The account of this research proceeds as follows.

Chapter 1 contrasts different theories about decision-making. First, I show how the project selection, effort level and project evaluation decisions should be made according to textbook Finance. Specifically, an individual's investment decisions are optimal if they are consistent with the theory of rational choice. The cornerstones of rational choice theory are thus introduced prior to outlining optimal decision making at each of the three stages of the capital investment decision process to be studied here. In a second step, evidence from Psychology that people sometimes make decisions in a non-rational way is presented. It is this dialectic which drives the further research, and out of which also the existing literature in Behavioural Finance has arisen, to which my work can be attributed.

This literature, which relates psychological phenomena to financial decisions, is reviewed in Chapter 2; the focus hereby is on contributions that are most relevant to the role of overconfidence and regret aversion in capital investment decision making. The literature review is structured according to the two biases. Its general purpose is to identify previous attempts to model and otherwise investigate overconfidence and regret aversion in financial decision making, so as to place the proposed research in context, and build on what has already been achieved. It is shown that there are large gaps in the literature, and that the proposed research will consequently be a novel contribution in several ways.

In Chapter 3, I present my own model of the capital investment decision process based on the theoretical background provided in the preceding chapters. Following a general outline of the standard model, I demonstrate how overconfidence and regret aversion may formally be integrated into this model consistent with the literature. Following the logic of backward induction, the model is solved by consecutive analysis of the project evaluation, managerial effort, and project selection decisions, with and without consideration of the two biases. Based on the contrast to optimal (unbiased) decision

behaviour, I derive testable propositions for the effects of overconfidence and regret aversion on the identified stages of the capital investment decision process.

In Chapter 4, I outline how the empirical data in this research was collected. The chapter first explores how previous research has addressed the task of data collection. From this review, it appears that most related studies in Finance used an experimental or survey design. The methodological considerations reveal considerable weaknesses of either approach taken by itself; these may, however, be offset when both methods are applied in combination. Following these reflections, a two-method design is retained, combining an internet-based survey questionnaire and two experiments. The remainder of that chapter then details the structure and underlying rationale of the questionnaire and the experiments.

The collected data for both the survey and the experiments is presented and analysed in Chapter 5. A discussion of the findings of this research, including potential limitations, is provided in Chapter 6. I also discuss whether overconfidence and regret aversion are desirable for shareholders, and what might be done in terms of corporate governance to reduce the impact of the two biases. The chapter closes with suggestions for further research and a conclusion on the role of managerial overconfidence and regret aversion in capital investment decisions.

CHAPTER 1: DECISION MAKING THEORY

This chapter provides the theoretical background for the unbiased (optimal) solution of the model later on. Capital investments were shown to be important in the corporate value creation process. Given this importance, research in economics and finance has come up with recommendations on how best to make the associated decisions. That theory is hence normative because it prescribes behaviour for a given choice problem. Normative theory is about how people should behave based on certain assumptions about their objectives and is to be distinguished from descriptive theory which is an account of how people actually behave, irrespective of whether such behaviour is optimal or not (Bell, Raiffa, & Tversky, 1988:16). Given their differing intentions and assumptions, normative and descriptive theories cannot be compared for the purpose of determining which is superior.

However, and this is the intention of the presented research, normatively optimal behaviour can serve as a benchmark for assessing observed behaviour. In this way, it is not the optimality of normative behaviour that is tested but rather its descriptive accuracy¹, hence the optimality of the observed behaviour. The purpose of this chapter is therefore to outline how each of the three studied capital investment decision problems – project selection, managerial effort, and project evaluation – should theoretically be made. The normative status of modern corporate finance theory is derived from its assumption of a rational decision maker. However, there is also evidence of human choice behaviour that is inconsistent with some of the axioms of rational choice.

1.1 Optimal choice behaviour

Standard textbook corporate finance theory assumes rational decision making. Prior to the review of what constitutes optimal capital investment decision behaviour, an outline of the core elements of the theory of rational choice is thus offered.

¹ Yet since normative theory is not meant to be descriptively accurate, such testing does nothing to question its validity.

1.1.1 Basics of rational choice theory

Rational choice theory was developed as a prescriptive theory for making decisions when the outcomes of the choice alternatives are risky or uncertain². Resources in the economy are scarce and choices need to be made. The theory of rational choice details how these choices should be made optimally. It consists of three theoretical pillars. In order to define optimality, rational choice theory draws on utility theory; hence, an outcome is optimal if it maximizes individual utility. The second pillar of rational choice theory is a set of logical decision rules (choice axioms), which specify individual preferences over different outcomes. Third, the theory of rational choice assumes that under conditions of uncertainty, forecasts are made according to the rational expectations hypothesis. Optimal behaviour then consists of maximizing subjectively expected utility. In this section, I introduce all of these elements.

Utility theory

In the late 18th century, a philosophical debate was being conducted in Economics about what motivates people's behaviour. This research is today known as the utilitarian literature, with Jeremy Bentham as a leading figure³. Under this approach, people are believed to pursue the satisfaction of their desires so as to achieve happiness. This notion of happiness, derived from the consumption or possession of a good was termed utility. Original definitions of the term utility interpret it as an immaterial benefit of owning or consuming a good or service. For instance, Adam Smith (1776) defines utility as 'value in use':

"The word value [...] has two different meanings, and sometimes expresses the utility of some particular object, and sometimes the power of purchasing other goods which the possession of that object conveys. The one may be called value in use; the other, value in exchange..." (Book I, Chapter IV, p.13).

Yet with the development of Economics to become a more scientific discipline, a more quantifiable concept was sought. This resulted eventually in a stark simplification of the interpretation of the term utility. Utility was simply assumed to be measurable in

² If there are several possible consequences to a decision, and if it is known how likely each outcome is, the decision is said to be risky; in contrast, uncertainty is defined as a situation where the probability distribution for the outcomes is not known (Knight, 1921).

³ Prominent opponents to Bentham's utilitarianism included John Ruskin and Thomas Carlyle.

monetary terms. In their landmark work on rational behaviour, John von Neumann and Oskar Morgenstern assume that

"the aim of all participants in the economic system [...] is money, or equivalently a single monetary commodity" (von Neumann & Morgenstern, 1953: 8).

This interpretation by von Neumann et al. (1953) permitted an ordinal (intra-personal) scaling of utility, meaning that greater utility is reflected by greater monetary value. As a consequence, preferences for choice options could be stated more easily in terms of value. Combinations of goods or decision outcomes that yield the same utility are graphically represented by an indifference curve. The preference order between different bundles is then illustrated by a utility function that intersects with each indifference curve. Thus, whilst early economists viewed human beings as seeking to maximise satisfaction, rational choice theory assumes because money can buy satisfaction that an individual makes choices in pursuit of wealth maximisation. Even though there may be substantial differences between satisfaction or happiness and wealth, this simplifying interpretation of utility as being equal to money has become widely accepted and also standard in Finance⁴. Consequently, economic agents aim to maximize wealth instead of pursuing happiness, and rational investing is assumed to be driven only by this consideration.

A particular property of the utility function that should be mentioned here, too, is its concavity, derived from the intuition that people are generally risk-averse, and that a bird in the hand is worth two in the bush; or, in more technically correct terms, that the utility of an expected (certain) gain is always greater than the (uncertain) expected utility of that gain, hence

$$(Eq-1.1) \quad U(E[X]) > E[U(X)]$$

The property of risk aversion can best be illustrated with a hypothetical gamble: A risk-averse individual is predicted always to prefer the opportunity of winning £1,000 for sure to the opportunity of winning £2,000 with a 50% chance or nothing otherwise. The product of an outcome with the probability of achieving it is called a 'prospect' (Kahneman & Tversky, 1979). In the given example, both prospects are of equal value. However, a risk-averse individual will prefer the certain to the risky prospect.

⁴ When risk-neutrality of the decision maker is assumed.

In contrast, someone who would always choose the risky over the safe prospect when both have about the same values because he enjoys gambling and taking a risk is said to be risk-loving (convex utility function). A third stylized risk preference type between these two extremes is risk-neutrality, where the utility curve is linear; a risk-neutral individual would be indifferent between the two options from above on the basis that their prospects are identical. Due to the linearity of the utility function, risk neutrality offers benefits for modelling and will also be assumed in the model presented later in this thesis⁵. Utility theory is furthermore based on a set of assumptions about decision making that formally describe rational choice behaviour. These axioms of rational choice are introduced in the next section.

Axioms of rational choice

An initial requirement of rational choice is to evaluate and rank all different choice options in terms of their expected utilities (preference ordering). Based on the work by von Neumann et al. (1953), a set of preference ordering rules was developed to become the foundation of rational information processing. In particular, the contributions by Luce & Raiffa (1957) led to the formalisation of the axioms of rational choice. A central characteristic of these rules is that they are inherently logical. Below, I present the most important axioms of choice only briefly, as they are not directly in the focus of my investigation. I largely paraphrase Weber & Camerer (1987:130-142) in this list.

- *Completeness*. The axiom of completeness states that for each pair of choices A and B, it is possible to compare the two outcomes, and that it is possible to determine a preference ordering such that $A > B$, $A < B$ or $A \sim B$.
- *Reflexivity*. If one outcome is viewed as better than the other by an individual such that $A > B$, then it is also true that $B < A$.
- *Transitivity*. Given completeness and reflexivity, an individual's preferences are furthermore assumed to be transitive such that if option A is preferred to option B ($A > B$) and option B is preferred to option C ($B > C$), then it follows that $A > C$.

⁵ As a result of making this simplifying assumption in this research, the predictions are limited to the special case of risk-neutrality. However, this is common practice in much of the literature in Finance.

- *Continuity*. For the uncertain events A, B and C, assume that $A > B > C$. Under continuity, a probability p exists such that an individual is indifferent between B with certainty and playing a lottery where he receives A with probability p and C with probability $(1-p)$. This implies that it is possible to construct a combination of choices A and C which is equally valuable to the individual as the ‘certainty equivalent’ B.
- *Independence / Substitutability*. If A is preferred over B, this preference remains independent of any transformations that are the same for both outcomes. Formally, if $A > B$, then for all outcomes Z and for all probabilities $p \in [0,1]$ it is also true that $pA + (1-p)Z > pB + (1-p)Z$. Consequently, the individual must be indifferent between a lottery and its certainty equivalent.
- *Monotonicity*. If two lotteries with the same alternatives differ only in probabilities, then the lottery that gives the higher probability to obtain the most preferred alternative is preferred.

Decision-making can only be deemed rational if choices are made in adherence with these rules.

Rational expectations

When the outcome of a choice option is less than certain, choice preference orderings must be developed on the basis of expected utilities (as opposed to known utilities). The expected utility [$EU(x)$ or $\hat{U}(x)$] of a gain [x_i] is effectively the product of the utility of the gain and the probability with which this outcome is likely to occur, hence

$$(Eq-1.2) \quad EU(x) = \hat{U}(x) = \int_{x_i \in \Omega} U(x_i) dP(x_i)$$

A fundamental problem here is clearly the estimation part. Assuming that outcomes may be known, how does one determine the probability of an event occurring? In the original version of rational choice theory by von Neumann et al. (1953), information on the probability distribution is assumed to be available in the form of historically observed frequencies. This data can then be used to generate estimates of future probabilities (frequentistic probabilities). Arguably, though, these circumstances are not representative of a truly uncertain decision problem, where historical information would not be available. Large investment projects may be assumed to be sufficiently unique for management not to dispose of such data (no prior experience).

Consequently, the decision maker is left with his best guess as to the likelihood of each possible outcome. These guesses are called subjective probabilities. An early theory of subjective probabilities was proposed by Leonard Savage (1954). However, subjective estimates could potentially suffer from being completely arbitrary, which would represent a serious limitation to the theory of rational choice in situations of uncertainty. This issue was resolved by the rational expectations hypothesis (REH), put forward theoretically by John Muth (1961) and stated formally by Robert Lucas (1972). According to the REH, rational (ex-ante) forecasts are very accurate predictions of the 'true' (ex-post) values:

"...since they are informed predictions of future events, [subjective expectations] are essentially the same as the predictions of the relevant economic theory" (Muth, 1961: 316).

In understanding why this should be so, the following quote from John Maynard Keynes (1937) is helpful:

"...the necessity for action and for decision compels us as practical men to do our best [...] and to behave exactly as we should if we had a good Benthamite calculation of a series of prospective advantages and disadvantages, each multiplied by its appropriate probability, waiting to be summed" (p.214).

Keynes appears to make reference to some external force that disciplines human behaviour to be rational. Exactly this is also the intuition behind the REH: Subjective forecasts are accurate because any systematic deviation from what can rationally be expected will be eroded by market forces (arbitrage). According to the REH, thus, subjective forecasts cannot be systematically biased, an assumption Hargreaves-Heap, Hollis et al. (1992) describe as follows:

"We can define the expectations which we expect instrumentally rational individuals to hold as ones which suffer only from random white noise errors; that is, the errors have a zero expected mean, constant variance and are serially independent" (p.17).

Mathematically, this central idea underlying the REH can be written as:

$$(Eq-1.3) \quad E(\varepsilon_t) = E(X_t - E[X_t | I_{t-1}]) = 0$$

where X_t : Forecast in time t

I_{t-1} : Information available in time t-1

Maximising subjectively expected utility

Having developed rational subjective forecasts for outcomes and corresponding probabilities, the decision maker should compute the subjectively expected utility [SEU] of each possible course of action. The SEU for one choice option is the weighted average of subjectively expected utilities for different states of nature, where the weights are the subjective probabilities (Elster, 1986:5). Taking into account the choice axioms specified above, rational decision making then involves ranking the choice alternatives based on their SEU and selecting the course of action (if alternatives are mutually exclusive) that has the highest rank (the highest SEU). Note again that SEU can be equated here with the subjectively expected (monetary) value of a decision due to the assumption of risk-neutrality of the decision maker.

With regard to the value of a decision, however, a potential difficulty arises when decisions are delegated, as in the case of large companies where shareholders employ managers to conduct the operations of the business. In this situation, it must be questioned if the utility of the manager is the same as that of shareholders, or if there is a divergence of interests. Two different opinions exist in the literature, agency cost theory (Jensen & Meckling, 1976) and stewardship theory (Donaldson & Davis, 1989). In agency-cost theory, the decision maker is assumed to pursue selfishly his own interests, which are not identical to those of the shareholders. If managers dispose of inside knowledge not available to shareholders (hidden information) or are able to take decisions without the shareholders' knowledge (hidden action), agency-cost theory predicts that there will be managerial shirking: The agent makes decisions so as to maximize his personal utility by seeking private benefits instead of pursuing shareholder value maximization that would be in the shareholders' best interest. The effort required to monitor managers' decisions, or to align⁶ their interests with those of the shareholders results in the cost of agency (Jensen et al., 1976:308). In contrast, under stewardship theory managers are assumed to pursue not their own utility maximization but the best interests of the shareholders (Davis & Schoorman, 1997:21). It should be stressed that even though agency cost theory predicts deviations in the manager's behaviour from what is normatively optimal, it still assumes the agent to be

⁶ A method of motivating managers to pursue shareholder value maximization that has been especially popular in practice is the use of stock option schemes (e.g. Gordon, 2004).

fully rational and maximize his wealth consistent with the three pillars of rational choice theory outlined in the preceding sub-sections.

To summarize, rational behaviour does not only imply utility or wealth maximizing behaviour. It also requires the decision maker to form expectations in line with the rational expectations hypothesis and process information consistent with the axioms of rational choice. The theory of rational choice thus pertains to "means rather than to ends" (Elster, 1986:1), whereby the optimal outcome is obtained as a consequence. Traditional models of Corporate Finance that can be found in standard textbooks adopt rational choice as the assumed behavioural *modus operandi* of the decision maker⁷ to show how an optimal outcome in a given finance problem can be achieved. Consequently, these models are normative theory. In the following section, I review the optimal decision rules for each of the three identified capital investment choice problems as defined by modern corporate finance theory.

1.1.2 Optimal capital investment decisions

My research focuses on three elementary steps of the capital investment decision process. My analysis begins at the point where a given investment proposal has become available to the decision maker. The first decision task of the manager is thus to decide whether to reject the proposal or whether to accept it. I define acceptance of a project as the commitment to commence an investment by expending an initial sum and bearing any associated financial consequences. The investment decisions studied in this research are thus irreversible in the sense that once resources are committed to an investment, they cannot be recovered. The second managerial choice problem is how much effort to exert in order to ensure the successful completion of the investment. Finally, it may become necessary to evaluate an ongoing investment project in order to determine if the project is still 'on track' and may be continued, or whether it would be advisable to terminate it. Based on the assumption of a rational decision maker who seeks to maximize shareholder value, corporate finance theory

⁷ The assumption of a rational decision maker is so common that it is referred to in the literature as the fictional character of the 'homo oeconomicus'.

offers relatively unambiguous guidelines on how to make optimal decisions⁸ in each of these three situations.

Project selection

The project selection decision must be taken following the net present value (NPV) rule⁹. This decision rule states that any investment with a negative NPV ($NPV < 0$) must be rejected. The NPV of an investment is equal to the sum of the discounted expected cash flows from the investment, minus the initial cash outlay. Formally,

$$(Eq-1.3) \quad NPV = \sum_{t=1}^n \frac{E(CF_t)}{(1 + r_0)^t} - I_0$$

where $E(CF_t)$: Expected cash flow in period t
 r_0 : Required rate of return (discount rate)
 I_0 : Initial investment outlay

The NPV is thus the absolute additional cash value created by a new investment stated at present terms, which can be positive or negative. The discount rate should account for the risk of the investment, opportunity cost of capital and the financing mix for the project. Although Finance textbooks contain other appraisal methods besides the NPV method, there is widespread agreement that these are inferior as they can potentially lead to wrong decisions (e.g. Brealey & Myers, 2000:113). For example, static methods like return on investment (ROI) and payback do not account for the time value of money. ROI belongs to the group of accounting data based measures, which are less accurate than cash flow based appraisal methods. Payback favours projects with large initial cash returns, regardless of whether they add or destroy shareholder value. Even the internal rate of return (IRR), which is closest to the NPV approach, will at times lead to the wrong decision (e.g. Seitz & Ellison, 2005:167-177); in

⁸ Several scholars (e.g. Carr & Tomkins, 1996; Jones & Lee, 1998; Adler, 2000) accentuate the importance of qualitative factors for investment decisions. In this research, however, it is assumed that strategic considerations are quantifiable and can hence translate and be expressed in monetary value terms.

⁹ Given that some investment projects share certain characteristics with financial options ('real options'), an alternative approach to the NPV rule is derived from options pricing theory (e.g. Ross, 1995). However, since real options pricing is also based on the principle of discounted cash flows of the NPV approach yet more complex, my research focuses on the net present value method alone.

particular, the IRR may be misleading when comparing investments that are different in several aspects (Kelleher & MacCormack, 2004).

As an exception to the NPV rule, Brealey et al. (2000:114) point out that a company with hard capital constraints may not be able to take every investment with a positive NPV. In addition, there is one situation when a project with a positive NPV cannot be accepted. This occurs if the project is mutually exclusive to another investment. Investments are mutually exclusive if the acceptance of one prohibits the acceptance of the other. For illustration, one may think of a plot of land that can be used to build either a factory (investment A) or a shopping mall (investment B). For mutually exclusive investments, the optimal procedure is to rank the competing alternatives based on their NPV and accept the one with the highest NPV. This procedure of developing a preference ordering is directly adopted from rational choice theory; consequently, it requires the axioms of rational choice to be applied.

Whilst theoretically any investment with a positive net present value may be undertaken, under no circumstances should a project with a negative NPV ($NPV < 0$) be invested in. Making an investment that has a negative NPV implies a destruction of value, and thus obviously conflicts with the rational objective of shareholder wealth maximization. Since the calculation of the NPV took already into consideration all benefits (including strategic benefits) in monetary terms, there can be no reason to invest in such a project. However, as the formula in (Eq-1.3) also shows, the NPV of an investment depends heavily on the estimates about future cash flows. When these cash flows are very uncertain, it follows that applying the net present value rule involves considerable uncertainty. However, under the standard paradigm, this is not deemed to be much of a problem as expectations are assumed to be rational.

Effort choice

I define managerial effort broadly as any input the decision maker can contribute to the successful conduct of an investment. Hence, managerial effort summarizes the different ways in which a manager may allocate skill, expertise, time and other resources to the management of the investment project. The notion of 'effort' is in fact rather well-established in the literature, particularly in the field of experimental game theory that looks at the effectiveness of incentive systems in principal-agent settings (e.g. van Dijk, Sonnemans, & van Winden, 2001). The reason why the work effort of individuals is of interest to academics is that there is typically a rising cost associated

with increasing effort such that effort choice represents an optimisation problem: The individual thus needs to trade off the benefits of effort against its costs. According to basic economic theory, this trade-off should follow the simple rule that an activity should be undertaken up to the point where its marginal cost equals the marginal benefit derived from that activity.

This stopping rule also applies to the decision problem of optimal managerial effort. Managers should exert effort to manage an investment only until the marginal cost of doing so is equal to the marginal benefit derived from the last unit of effort exerted this way. Simple as this rule may sound in theory, however, its application is not as straightforward. Specifically, two aspects are of relevance to this study. For one, there is the problem of who is affected by the cost of effort. In many cases, it is assumed that the cost of effort is internal to the manager, following the intuition that working harder reduces your utility (Mattsson & Weibull, 2002). Under this perspective, shareholders would not be negatively affected by increasing managerial effort and hence the optimal level of effort for shareholder value maximization would theoretically be unlimited. However, since my research abstracts from conflicts arising from a misalignment of interests between shareholders and the decision maker, I consider the cost of effort as a reduction of the expected value of an investment, which hence affects shareholders.

This assumption should be no less intuitively plausible than interpreting the cost of effort as a disutility to the manager. Many resources that are deployed as part of managerial effort may for instance be associated with a real variable cost. For instance, if personal inspection and supervision of an investment project by the manager were to involve significant transport and travel costs, greater effort in this sense would directly hit corporate profits and thus shareholder value. In addition, the cost of effort may also be understood as an opportunity cost of managerial time and energy, or, more generally, of any resources allocated to one specific investment rather than to a different one. In spite of the traditional interpretation, there are thus also intuitive arguments that justify my assumption of the cost of effort directly and fully reducing shareholder value in reality. Moreover, from a theoretical point of view, a function for an external cost should be more tractable than that for an individual's disutility from extra work.

While thus the cost of effort may often be known with relative ease, a second difficulty associated with adhering to the decision rule for normatively optimal effort is due to the potential obscurity of the (marginal) benefits of higher effort. Specifically, this

requires an estimation of the extent to which the individual's extra effort is able to increase the value of an investment at the margin. In addition to limiting or accommodating external factors, it is assumed here that individual competence – or the 'quality' of the effort – plays an important part in the effectiveness of managerial effort. Determining the marginal benefit of effort consequently requires the decision maker to estimate the extent to which his personal ability, by means of his own effort contribution, can positively influence the expected value of an investment project. The accuracy of this estimate is thus a function of the accuracy of the manager's self-view, that is, how well he knows what he is able to do. Under the standard paradigm of rational decision-making, the manager is assumed to have a correct self-view and thus make a rational estimate of the marginal benefit of his effort.

Project evaluation

Although accepting an investment was defined to be committing in the sense that an initial allocation of funds had to be made, this does not imply that an investment that was accepted has to be continued until completion. Instead, I make the assumption that there is at least one point in time ('milestone') at which it is possible to terminate an investment prior to completion, that is, earlier than was originally planned. For instance, due to an unforeseen shift in consumer demand, the development of a production facility for a new product may suddenly no longer be required. If construction of the new facility has already started and progressed to some extent, management will have to decide whether to continue or to halt building. If completed, the facility may create value in some alternative use but it may also create future costs without contributing to revenues; on the other hand, terminating construction work may also involve further payments for instance to building contractors as compensation for loss of earnings.

This general decision problem of continuing or abandoning an ongoing investment project is termed 'project evaluation' and constitutes the third and final stage of the capital investment decision process studied in this research. In particular, I assume that the manager observes that an investment he has undertaken is underperforming in the sense that it is now expected to incur losses in the future based on a renewed assessment. According to normative Finance theory, the abandonment / continuation decision (project evaluation) should be taken based on the net present value rule, since continuation of the investment would be analogous to undertaking a new investment.

The manager should thus calculate the net present value of either¹⁰ of his choice options. If this evaluation shows that the investment, if continued, would result in a negative NPV, the manager should abandon it, unless the termination value is even lower than the continuation value.

Hence, Finance theory uses the logic of the NPV method to propose a clear decision rule for the project evaluation decision problem: An ongoing project should only be continued if its NPV in the case of continuation is greater than the NPV of immediate termination. Moreover, normative theory specifies that in these calculations, a forward-looking stance should be adopted such that only incremental cash flows are taken into account (Brealey et al., 2000:123). Any preceding expenses on the investment should not be considered in the project evaluation decision, as these represent 'sunk costs', costs that cannot be recovered (Baumol & Willig, 1981). According to general economic wisdom, such unrecoverable 'bygones' must be ignored in rational decision-making. Project evaluation thus essentially consists of a comparison of the discounted future cash flows expected for project continuation with those for project abandonment, and pursuing that choice option which has the greater net present value.

1.1.3 Evidence of non-rational behaviour

Shortly after a formalized theory of rational choice was presented, it was criticised based on observations that could not be reconciled with some of the theory's core elements. Two particularly well-known examples that put into question the descriptive accuracy of some of the core assumptions of rational choice theory are the 'paradoxes' attributed to Maurice Allais (1953) and Daniel Ellsberg (1961). Both experiments have been frequently replicated and their findings found to be robust. These findings have been called paradoxical because they demonstrate that people systematically make simple choices that violate axioms of rational choice theory. In the experiment by Allais (1953), subjects are faced with two gambles as in the example in Figure 1.1. The first gamble is a choice between a guaranteed (certain) amount of money and a larger but risky amount. The findings are generally that the majority of subjects always choose Option A in the first gamble, but prefer Option B' in the second gamble.

¹⁰ In reality, the project evaluation decision may consist of more choice options than abandonment or continuation, but the analysis in research is restricted to those two possible courses of action.

Figure 1.1: The Allais-Paradox – Example

<i>Option A:</i>	<i>Receive € 2000 with certainty (chance of 100%)</i>
<i>Option B:</i>	<i>Receive € 3000 with a chance of 80%, and nothing otherwise</i>
<hr/>	
<i>Option A':</i>	<i>Receive € 2000 with a chance of 25%, and nothing otherwise</i>
<i>Option B':</i>	<i>Receive € 3000 with a chance of 20%, and nothing otherwise</i>

What is interesting about this observed choice behaviour is that it is not rational. The choice options in the second gamble [A' and B'] are merely modifications of the options in the first gamble [A and B], in that the probabilities for the payouts were divided by four, with the likelihood of no gain adapted accordingly. According to the axiom of independence, however, this type of transformation should have no effect on an individual's preferences.

Perhaps even more intriguing are the choices observable in the framework of Ellsberg's (1961) experiment. In that experiment, subjects are asked to make two independent choices in two gambles, and are consistently found to violate subjective expected utility theory. One version of the experiment is related by Barberis & Thaler (2003) and briefly repeated in the following: Subjects are informed that there are two urns, each containing 100 balls. Urn 1 contains 50 red and 50 blue balls. In Urn 2, there are also only red and blue balls, but subjects do not know how many there are of each colour. Two gambles are proposed (Figure 1.2) and subjects are asked to choose the preferred alternative in each gamble. In the first gamble, a ball is drawn at random from each urn. Subjects receive money if this ball is red and they correctly indicated the urn from which the red ball is drawn.

Figure 1.2: The Ellsberg-Paradox – Example

<i>Gamble 1:</i>		<i>Payout</i>	
<i>Option a1:</i>	<i>a ball is drawn from Urn 1</i>	<i>\$100 if ball is red</i>	<i>\$ 0 if ball is blue</i>
<i>Option a2:</i>	<i>a ball is drawn from Urn 2</i>	<i>\$100 if ball is red</i>	<i>\$ 0 if ball is blue</i>
<hr/>		<hr/>	
<i>Gamble 2:</i>			
<i>Option b1:</i>	<i>a ball is drawn from Urn 1</i>	<i>\$ 100 if ball is blue</i>	<i>\$ 0 if ball is red</i>
<i>Option b2:</i>	<i>a ball is drawn from Urn 2</i>	<i>\$ 100 if ball is blue</i>	<i>\$ 0 if ball is red</i>

Source: Barberis & Thaler (2003: 1072)

Results from this experiment show that subjects typically prefer Option a1 to Option a2, yet choose Option b1 over Option b2. As the rational reader may have noticed, such decision behaviour conflicts with rational choice theory because it appears to indicate that the concept of subjective probability estimates fails descriptively: A person who chooses Option a1 must necessarily believe that Urn 2 contains fewer than 50 red balls. Given that there is a total of 100 balls in each urn, the individual who believes that Urn 2 contains fewer than 50 red balls must also believe that it contains more than 50 blue balls. Hence, in the second gamble, Option b2 should rationally be preferred to Option b1. Concerning the robust observation that people do not behave according to this logic, Ellsberg (1961:656) notes:

"...the choices themselves do not appear to be careless or random. They are persistent, reportedly deliberate, and they seem to predominate empirically; many of the people who take them are eminently reasonable, and they insist that they want to behave this way, even though they may be respectful of the Savage axioms."

The pervasiveness of such violations of the rational choice axioms was further underlined by the account that even Leonard Savage was among those who made illogical and non-rational choices in Ellsberg's experiment.

What these early findings show is that even in an economic context, people do not always behave rationally (in the sense of conforming to rational choice theory), but that apparently there are situations in which the human brain struggles to correctly process the available information. A rather remarkable illustration of the pervasiveness of such cognitive limitations is the task presented in Figure 1.3.

Figure 1.3: Example of cognitive errors

Please read the text below. Next, count how many times the letter F occurs. How many instances of the letter F can you find?

FINISHED FILES ARE THE
RESULT OF YEARS OF SCIENTIFIC
STUDY COMBINED WITH THE
EXPERIENCE OF YEARS

Source: www.neuro.psychologie.uni-saarland.de/downloads/0405/biopsy_vorl/VL4-18-02-04_text.ppt

Although this task may be argued to be partly an optical illusion, it clearly also involves basic mental processes. This exercise is so astonishing because someone who

encounters it for the first time will typically fail it, but when made aware of the underlying mechanism will not comprehend how an incorrect answer could have been obtained before. Most people find that the letter F occurs three times. However, the letter actually occurs six times. Apparently, this phenomenon is attributable to the difficulty our brain seems to have in processing the letter F if it forms part of the word 'of'. Although this type of cognitive illusion lies beyond what is treated in the present research, the example demonstrates that there are ways in which the information processing of the human brain is systematically biased. The remainder of this chapter introduces research on the psychology of decision making under uncertainty that pertains to the context of capital investment decisions, with the focus being placed on the two biases my research focuses on, overconfidence and regret aversion.

1.2 The psychology of decision making

Evidence of human decision behaviour that conflicts with what would be optimal under rational choice theory prompted several scholars to propose alternative theories of choice. The one most protective of the rationality assumption is Simon's (1955) theory of bounded rationality, which is briefly introduced in the following. Since the days of Simon, however, the notion of full rationality has become less sacrosanct as psychologists started to make their findings more accessible to researchers in economics and related disciplines. An overview of these findings is also presented in this section. Given the large number of psychological biases, and the fact that not all are equally established, though, I decided to focus on the phenomena of overconfidence and regret aversion, which are reviewed in detail in the third part of this section.

1.2.1 Boundedly rational decisions

Bounded rationality theory was proposed by Herbert Simon¹¹ as a descriptive theory of choice. At the heart of his theory lies the assumption that in reality, a decision maker is faced with different types of limitations preventing him from behaving optimally. These limitations can be external or internal to the individual; for instance, an internal limitation to the complete adherence to optimal decision making would be a

¹¹ Simon received the Nobel Prize in Economics (1978) for his research on corporate decision-making.

person's computational ability (Simon, 1955:101). The boundedly rational decision maker can consequently only gather and process a limited amount of choice alternatives. In financial and economic models, bounded rationality is often interpreted as a cost of effort: "[the agent] wishes to make a normatively optimal decision but at the same time is constrained by the costliness of the effort" (Ofek, Yildiz, & Haruvy, 2002:4). As a consequence, the individual cannot optimise but merely satisfice (Simon, 1955:104).

One problem with Simon's concept of bounded rationality is that a clear interpretation of it was missing. When modelled as an external cost of effort, or as limited (intellectual) ability of the decision maker, it seems that bounded rationality still assumes a fully rational individual who simply is faced by certain limiting aspects of reality. In this sense, bounded rationality theory is quite different from the present research. On the other hand, if one places more weight on the role of limitations and information processing deficiencies internal to the individual, bounded rationality tends more towards the psychology-oriented literature. Perhaps, however, this ambiguity was intentional. Simon (1955:100) himself saw his theory as a "marking stone placed halfway" between psychologists and economists. Half a century later, a large number of decision biases have been shown to be directly relevant to financial decisions, and the gap between psychologists and economists has narrowed further.

1.2.2 Non-rational decision biases

The general picture of the human mind that appears to be dominating in modern psychology is that of a dual process system of information processing (Kuehberger, 2002:446; Stanovich & West, 2000:658). At the risk of oversimplification, one may summarize this view as suggesting that one part of the human brain thinks analytically and rationally, while the other part thinks intuitively and emotionally. The instinctive system can at times override the rational system, leading us to make seemingly irrational decisions. Among the phenomena that may affect our behaviour, a distinction can be made between visceral factors such as hunger or thirst (Loewenstein, 1996), emotions like guilt, joy or regret (Elster, 1998), and cognitive biases or heuristics. A problem with the different psychological biases identified by psychologists, however, is that they are not all readily accessible for outsiders to the discipline. For this reason, credit needs to be given to the pioneering work published by Daniel Kahneman and Amos Tversky, perhaps most widely known for their 'Prospect Theory' from 1979.

Their research showed the relevance of simple facts about the workings of the human mind for Economics and Finance topics. The significance of their contribution was acknowledged by the award of the Nobel Prize to Daniel Kahneman¹² in 2002. Kahneman et al. (1979) demonstrate in a series of experiments that the human mind is predisposed to commit cognitive errors when it has to make economic decisions that are risky or uncertain. In those circumstances, the information processing of the human brain fails to conform to the axioms of rational choice. The two researchers use experimental settings that capture essential financial or economic decision problems. For instance, when presented with the choice between a certain gain and a slightly larger, but risky gain, a majority of subjects regularly preferred the certain gain. Kahneman et al. (1979:265) term this phenomenon the certainty effect. Interestingly, the reverse behaviour is observable for losses: While subjects are found to be risk-averse in gains, they are risk seeking in losses (p.268).

These observations lead Kahneman et al. (1979) to propose that the human utility curve ought to be thought of as S-shaped, a central feature of the authors' 'Prospect Theory', which is a descriptive theory of choice under risk and incorporates a range of biases such as mental accounting or framing. Mental accounting refers to the way in which the human mind records and analyzes financial transactions, which is different to the way this is done in financial accounting (Thaler, 1999:157). One effect of mental accounting is that sunk costs are not ignored (Statman & Caldwell, 1987:9), even though it is economic wisdom that there is no use in 'crying over spilt milk'. Framing leads people to evaluate choice options according to the way they are presented instead of only focussing on relevant differences between them (Tversky & Kahneman, 1986:261). This list could be continued, since a range of other decision biases have been discovered over the years. However, good and rather exhaustive surveys of decision biases already exist, see for instance Rabin (1998), Slovic (2001) or Hirshleifer (2001).

Following my review of the literature on the different biases, I concluded that overconfidence and regret aversion should not only be relevant in a capital investment decision context, but that they are also among the most interesting phenomena. For one, both either can explain the existence of a number of other biases or are direct effects of them, hence taking a central position in the larger picture of cognitive biases.

¹² Amos Tversky died in 1996.

In addition, the characterisation in the psychology literature lets them appear as being rather opposite as far as their general behavioural effects are concerned. This aspect should make a joint analysis of the two biases particularly interesting.

1.2.3 Overconfidence and regret aversion

Overconfidence and regret aversion are among the most robust and well-documented psychological phenomena. Both have been found to affect decisions under uncertainty systematically. In this section, I review some of the theoretical background of the two biases, which will also be drawn upon in the development of my model.

Overconfidence

The term overconfidence is used somewhat ambiguously in the literature. Griffin & Varey distinguish between two ‘types’ of overconfidence. Overconfidence in the narrow sense is defined as "the overestimation of the validity of one’s judgment" (Griffin et al., 1996:228). The other form of overconfidence identified by Griffin et al. (1996) is optimistic overconfidence, "the tendency to overestimate the likelihood that one’s favoured outcome will occur" (p.228). Although such a distinction is useful for analytical purposes, casual observation and common logic seem to support the claim that it is unlikely that someone who overestimates his ability, skill and knowledge is not also simultaneously somewhat optimistic about his future. Optimism is thus included in the definition of overconfidence in my research.

De Bondt & Thaler (1995:389) assert that overconfidence is "perhaps the most robust finding in the psychology of judgment". By definition, overconfident individuals suffer from a deficiency of their meta-knowledge (Zacharakis & Shepherd, 2001) and thus believe they know more and better than they actually do, both in absolute and relative terms. Svenson (1981) showed the pervasiveness of overconfidence in a survey of car drivers; well more than half of the questioned drivers rated themselves as being ‘above average’ in terms of their driving skills, which is of course statistically impossible. Other groups of people were also found to be generally overconfident¹³, including engineers (Kidd, 1970), entrepreneurs (Cooper, Woo, & Dunkelberg, 1988) and different types of managers (Russo & Schoemaker, 1992). In the survey by Russo et al.

¹³ See also Barber & Odean (2001:263)

(1992), practically all of the 2,000 participating managers were found to be overconfident (p.9).

An interesting question, and one that is also relevant for investigating overconfidence, is whether overconfidence is endogenous or exogenous. On the one hand, there is research claiming that overconfidence is associated with factors outside the individual, thus supporting the notion that overconfidence may be – at least partly – exogenous, too. For instance, Fischhoff, Slovic, & Lichtenstein (1977) find that overconfidence increases in task complexity. Brenner, Koehler et al. (1996:213) even argue that task difficulty is the main determinant of the level of overconfidence. Furthermore conducive to overconfidence appear to be past achievements. In combination with the self-attribution bias, where individuals interpret past successes as confirmation of their ability whilst ascribing failures to bad luck (Shefrin, 1999:101), a positive performance track record may well strengthen overconfidence. Other researchers have suggested that biases may exist for evolutionary reasons (Cosmides & Tooby, 1994). In particular, a positively biased self-image may be beneficial for mental health, well-being and one's social life (Taylor & Brown, 1988:193), and thus ultimately, for survival. Overconfidence makes us feel better about ourselves and our future, and could thus be a desirable trait for the individual. As Stracca (2004) notes, "agents may draw some emotional gains from the perception of being smarter than others" (p.383), while they may "find a poor self-image painful" (Bénabou & Tirole, 2002:872).

Yet there are also reasons to believe that overconfidence has endogenous roots. It was mentioned before that overconfidence may be the result of certain cognitive biases. Griffin & Tversky (1992) argue that the human mind tends to focus more on the strength of a signal than on its weight (p.413). The confirmatory bias leads people to only consider information that supports their preconceptions, discarding contradictory evidence (Rabin & Schrag, 1999), and may hence be further conducive to overconfidence. In addition, Langer (1975) observes that experimental subjects behave in a decision task where the outcome largely depended on luck as if they could control it, and terms this bias 'illusion of control'. People apparently consider the factors they can control in a given situation much more than those beyond their control, which leads them to be overly confident about the situation and its outcome. Ellen Langer (1975:323) reports a positive relationship between illusion of control and confidence levels. Similarly, Weinstein (1980) proposes that overconfidence is more likely if someone feels he is 'in control'. Further support on the notion of overconfidence being

endogenous comes from Klaczynski & Fauth's (1996) finding that overconfidence increases in individual intelligence. Other research also seems to suggest that confidence¹⁴ is related to gender, with men being more confident, and certain psychometric personality traits (Furnham, Moutafi, & Chamorro-Premuzic, 2005). People may thus be assumed to have different individual levels of overconfidence. This assumption is further supported by research on individual differences (e.g. Pallier, Wilkinson et al., 2002).

In conclusion, it may thus be stated that overconfidence is a well-established psychological phenomenon. It has been found to affect decisions that are similar in nature to those of the capital investment decision process, and considerable work has been conducted on how individual overconfidence may present itself. Given the presented evidence, it thus appears justified to consider the role of overconfidence in a financial and investment decision context.

Regret aversion

Prior to turning to regret aversion, it is helpful to note some properties of regret itself. A good and frequently cited definition of regret is the following:

"Regret is a more or less painful cognitive and emotional state of feeling sorry for misfortunes, limitations, losses, transgressions, shortcomings or mistakes." (Landman, 1993:36).

Primarily, regret is thus an emotion, and additionally a negative one. A typology of emotions can be found in Elster (1998). Following Elster's categorization of emotions, regret is a counter-factual emotion as it is "generated by thoughts about what might have happened but didn't" (p.48). People thus compare, after a decision was made, the resulting outcome with an alternative that might have been obtained had they taken a different course of action. As Loomes & Sugden, who proposed a theory of regret simultaneously with Bell (1982), summarized later:

"The central intuition behind regret theory is that the utility derived from the consequence of a choice is dependent upon the outcome(s) of the alternative(s) foregone, given the state of the world that occurs." (Loomes et al., 1992:18).

¹⁴ Confidence measured as the accuracy of self-estimated intelligence.

Hence, regret arises from the ex-post comparison of two different outcomes – the one realized and the best one foregone. If the outcome obtained is less than what could have been achieved under an alternative strategy, there will be regret. An interesting observation many people may have made regarding their own feelings is that one can even regret a decision that seemed optimal at the time. Although we remind ourselves that action 'x' was optimal at a particular moment, given the information we had then, the fact that we know now that action 'y' would have been better bothers us emotionally. Regret may be felt even though we know we did the best we could, because retrospectively, people tend to underestimate the uncertainty that prevailed at the time of the decision making (hindsight bias; Fischhoff, 1975).

As a negative emotion, regret hurts. It is painful for us “when we find, too late, that a different choice would have led to a better outcome” (Statman, 2001:9). Most people seek to avoid this emotional pain because it represents a disutility. Consequently, human beings have a “desire to avoid post-decision regret” (Bell, 1982:979). The interesting implication of this is not only that we are able to feel regret (unlike the *homo oeconomicus*), but that our brain is capable and regularly engaged in the forming of forecasts of potential pain of regrets we might have later. Moreover, already this expectation can affect our behaviour. Research in cognitive psychology confirmed that human behaviour is influenced by the anticipation of potential regret associated with a decision or course of action (Loomes et al., 1982; Bell, 1982). Aversion to regret is particularly great when the individual is directly held accountable for the decision, when stakes are high, and for decisions under uncertainty (Isen, 2000). If the outcome of different decision alternatives is uncertain, there can be no strategy that does not potentially lead to feelings of regret. Under uncertainty, regret-averse decision makers estimate the potential ex-post regret associated with each possible choice option and consider the expected¹⁵ disutilities in their decisions. Of course, this leaves the question of what precise behavioural effect the aversion to anticipated regret may have. In the simplest of choice situations, an individual can always choose between ‘yes’ or ‘no’, that is, between ‘action’ (commission) or ‘inaction’ (omission). In order to predict which of the two alternatives is favoured by regret aversion, one must know whether the regret people have felt in the past is on average greater for ‘actions’ or for

¹⁵ An interesting question in this context is whether such expectations of future emotions are accurate (Loewenstein, O'Donoghue, & Rabin, 2003).

‘inactions’. Gilovich & Medvec (1995) discover a temporal pattern to how regret is felt. They suggest that in the long run, regret appears to be greater for inactions (Gilovich et al., 1995:391). This is to some extent supported by the findings from Feldman, Miyamoto, & Loftus (1999). Their results indicate that over his lifetime, an individual more often regrets inactions than actions. Contrarily, in the short term, people seem to regret more having done something they wish they had not done (Gilovich et al., 1995:392). Such a pattern would mean that regret aversion leads to inaction when the evaluative horizon for an individual’s behaviour is more oriented toward the short term. On the other hand, when an individual’s decisions are made with a view to the long run, regret aversion might result in a tendency to more action. Early empirical research on regret aversion is conducted by Loomes et al. (1992), who test experimentally certain violations of rational choice predicted by regret theory. However, their findings are somewhat inconclusive: Despite observing violations of the monotonicity principle, the predicted violation of equivalence cannot be supported by their data (Loomes et al., 1992:29). Experiments that are more recent provide stronger evidence to support the notion that individuals will behave in a regret-averse fashion. Zeelenberg, Beattie et al. (1996) show that regret aversion can lead to risk-seeking as well as risk-averse behaviour in risky choice problems. In a follow-up article, Zeelenberg & Beattie (1997) employ an ultimatum game design for their experiment to study the effect of regret aversion under uncertainty. These more recent results thus deliver further support for the existence and impact of regret aversion:

"People are motivated to avoid or minimize post-decisional regret. This motivation exerts impact on their decisions, because the probability of future regret is anticipated and taken into account when making decisions" (Zeelenberg et al., 1997:76).

1.3 Summary

In this chapter, I presented the relevant theoretical underpinnings for my analysis of the role of overconfidence and regret aversion as biases to managerial capital investment decision making. In a first step, central elements of rational choice theory were revisited in order to portray the traditional view of economic decision behaviour. The normative status of rational choice theory is the foundation of the normative status claimed by modern finance theory. Given my definition of the capital investment decision process as consisting of project selection, managerial effort, and project

evaluation (continuation or abandonment of an ongoing investment), optimal decision behaviour as recommended by modern finance theory was outlined.

In the second part of this chapter, a contrasting and descriptively more accurate view of human decision making under uncertainty was introduced. Under this paradigm, decisions are not fully rational and are affected frequently and systematically by psychological biases. In particular, the two phenomena studied in the present research, overconfidence and aversion to regret were shown to be well established and theoretically relevant to the context of capital investment decisions. Furthermore, key findings from Psychology on overconfidence and regret aversion were described, and shall serve as foundations for the remainder of the present research. Naturally, this presentation does not do full justice to what has been discovered in Psychology on the topic of overconfidence and regret aversion, yet it is argued that the gained insights are solid and detailed enough to serve as a theoretical basis for the further study of the effects of these two phenomena.

In terms of a simplified synopsis, overconfident individuals have an overly positive opinion of themselves, whilst regret aversion is the tendency to make choices so as to minimize potential future regret. To some extent, thus, both biases may be related by effectively protecting an individual's emotional well being. For this reason, in addition to the identified pervasiveness of overconfidence and regret aversion, it is thus also plausible to focus on specifically these two biases. Moreover, since both seem to be particularly relevant to decisions under uncertainty it seems reasonable to suggest that they should also matter in managerial capital investment decisions. The argument that an investigation into the role of overconfidence and regret aversion in these decisions is justified is further supported by existing research in behavioural finance that has considered both biases in different decision tasks. This literature is reviewed in the next chapter.

CHAPTER 2: BEHAVIOURAL FINANCE

In view of the strong evidence of psychological factors affecting decision behaviour, it is unsurprising that other researchers have linked these phenomena to financial decision making in the past. The resulting accrued body of theory is grouped under the label Behavioural Finance owing to its focus on explaining actual behaviour in contrast to the standard normative theory that prescribes optimal behaviour. Given its orientation, my research seeks to add to this literature. The literature review in this chapter thus has a number of purposes. Its primary function is to offer an overview of the existing work in the field of Behavioural Finance, in order to delineate my research from and show its contribution to the existing body of research. The theories and findings presented in the following were also the initial point and a source of inspiration for my theoretical model and the ensuing empirical work reported in later chapters, and are therefore important in justifying my research topic and demonstrating its relevance. The chapter continues as follows. I begin by introducing the field of Behavioural Finance in general. The remainder of the chapter then has two main parts. Part one is dedicated to the application of overconfidence to financial decisions; whilst part two reviews treatments of regret aversion in financial decisions.

2.1 What is behavioural finance?

Research in Finance that relaxes the assumption of full rationality by integrating findings from the study of human psychology is referred to as Behavioural Finance. Behavioural Finance is thus a descriptive theory of how financial decisions are made, as opposed to standard (modern) Finance that offers theories on how decisions should be made. The common theme of research in behavioural finance is that decisions under risk and uncertainty are in reality affected by factors from human psychology¹⁶, and that consequently, behaviour may deviate from the patterns prescribed under the rationality paradigm of traditional finance. Early research in behavioural finance was triggered by the work of Daniel Kahneman and Amos Tversky, and by anomalies in

¹⁶ John Maynard Keynes already conjectured that decisions under uncertainty contain at best a small element of rationality, and are instead driven by non-rational 'passions' (Marchionatti, 1999:414ff).

financial markets. Persistent mispricings such as the 'twin shares' phenomenon¹⁷ (Barberis et al., 2002:1061) were taken as evidence that arbitrage was not perfect and that a case for the existence and pervasiveness of biased behaviour could be made. Other anomalies that set off Behavioural Finance research are the equity premium puzzle (Mehra & Prescott, 1985), the high volatility in stock markets (Shiller, 1981) and the predictability of stock returns (Fama & French, 1988). Early research in Behavioural Finance thus attempted to provide frameworks that could explain such observations outside the rational choice paradigm.

Yet by challenging this assumption ground of standard Finance, researchers faced strong criticism. Perhaps most famous is the article by Eugene Fama (1998) who reviews contributions that put forward cognitive explanations of the over- or under-reaction of financial markets to new information, such as Daniel, Hirshleifer, & Subrahmanyam (1998) who explain overreaction through investor overconfidence. Fama (1998) defends the theory of efficient markets (rational market participants) by criticizing these behavioural studies on three accounts. First, the fact that both over- and under-reaction have been found – but no unified explanation for this – should be interpreted as indicative of an overall efficient market where deviations average out (Fama, 1998:287). Further, Fama (1998:288) claims that most of the anomalies investigated by Behavioural Finance are artefacts and the results of a flawed methodology¹⁸. A final main point of criticism is then that behavioural models are only useful in explaining the particular event they were developed to explain but have no wider relevance as they fail to explain "the big picture" (Fama, 1998:291). In a similar spirit, Merton H. Miller, co-author of the classic Modigliani & Miller (1958) article on capital structure irrelevance, feels the need to warn that research into the "stories" behind some decisions may be a waste of time and resources (Miller, 1986:467)¹⁹.

According to Keren (1996:169), this perhaps surprising degree of tension between traditional and behavioural finance theorists can be explained by the interrelation or

¹⁷ Ever since Royal Dutch and Shell Transport merged in 1907, the stocks of their independently quoted entities should be priced in a ratio of 60:40 (as they represent shares in one company only). However, from 1981 onwards, the two prices departed substantially over several years from this ratio (Froot & Dabora, 1999).

¹⁸ Gigerenzer, Hoffrage, & Kleinboelting (1991) and Erev, Wallsten, & Budescu (1994) also argue that a flawed methodology is the reason for findings of overconfidence.

¹⁹ See Statman (2005:32).

entanglement of descriptive and normative. Arguing that over- and under-reaction can be explained within the efficient market model through random chance (Fama, 1998:287) is indicative of the belief “that the normative presents not only the ought but also the is” (Keren, 1996:169). De Bondt et al. (1995) jokingly stylize the problem of Finance theory's “presumed dual purpose” (p.387) in the following quote: "Finance consists of theories for which there is no evidence and empirical facts for which there is no theory" (De Bondt et al., 1995:386). The authors emphasize the importance of a clear distinction between the normative role of traditional finance theory, and the descriptive models of Behavioural Finance. Moreover, reducing behavioural biases such as overconfidence to statistical errors or methodological problems is not doing justice to the overwhelming and varied evidence:

"...it is evident that overconfidence is not eliminated by random selection of items, it does not disappear in estimates of relative frequency, and it cannot be treated merely as a regression artefact" (Brenner et al., 1996:218).

In an outlook on the development of economic theory, Richard Thaler²⁰ (2000:140) predicts that the fictional character impersonating all of the features of a fully rational decision maker, the 'homo oeconomicus', will evolve to become the 'homo sapiens'. What he thus suggests is that the decision-behaviour assumptions used in future economic models will progress to become more descriptively accurate of actual human behaviour:

"My prediction is that in future seminars, presenters will have to explain why they are using a model with only rational agents (unless the paper is on the history of economic thought)" (Thaler, 2000:136).

For some, however, the departure from the traditional finance paradigm made by researchers in behavioural finance is not radical enough. Frankfurter & McGoun (2002) lament a "fatal attraction" (p.385) of the field to elements of the rational choice paradigm: Behavioural models often still assume the existence and optimality of rational behaviour as a benchmark. Nevertheless, since a lot of financial theory, which is built on the assumption of rationality, is at least normatively appealing and widely

²⁰ Richard Thaler is Professor of Behavioral Science and Economics at the University of Chicago and Research Associate at the National Bureau of Economic Research (NBER) of the United States of America.

used in practice, traditional models do provide a useful benchmark. In addition, Frankfurter et al. recognize the practical difficulties associated with conducting revolutionary research:

"Finance itself is burdened with its large investment in the old paradigm, and no one, young or old can get out from under it. [...] How does one write a Ph.D. dissertation in finance without a committee knowledgeable in and supportive of behavioral finance?" (Frankfurter et al., 2002:387)

In the meantime, as is certainly the hope of the present author, opinions may have evolved a little. There are signs that even traditionalists acknowledge that Behavioural Finance "has passed the critical level of acceptance for some time now" (van der Sar, 2004:441). For instance, the recognition given to leading-edge research in game theory, that enriches traditional strategic decision problems by incorporating arguably 'soft' factors such as 'fairness' or 'reciprocity' (Anderhub, Gaechter, & Koenigstein, 2002; Camerer, 1997; Fairchild, 2002) indicates that insights into how human beings actually behave is becoming more widely accepted. In 1999, Richard Thaler even proclaimed the "end of behavioural finance", in the sense that it has ceased to be a discipline of controversy and is in the process of merging with mainstream finance:

"...in the not-too-distant future, the term 'behavioral finance' will be correctly viewed as a redundant phrase. What other kind of finance is there?" (Thaler, 1999:16).

This process also may be reflective of Nobel Prize laureate²¹ George Akerlof's (2002) vision of the future of economic theory. Akerlof calls for a renewed appreciation of elements of Keynes' (1936) 'General Theory', such as the incorporation of psychological biases as more realistic model assumptions (Akerlof, 2002:411). As this comment also shows, assuming decision makers to be somewhat less than fully rational is not entirely new, even if the psychological findings nowadays are more advanced than they were in the days of Keynes. In fact, rather the opposite is true: Statman (2005) reminds us that it is the assumption of *rational* decision makers that is only rather recent. Contrasting rational with normal agents, where the latter are affected by cognitive biases and emotions (p.34), he argues that

²¹ George Akerlof received the Nobel Prize for Economic Science in 2001 for his analysis of markets with asymmetric information.

“...investors were normal before Miller and Modigliani described them as rational [in the early 1960s], and they remain normal today.” (Statman, 2005:33)

In summary, Behavioural Finance is thus new literature on an old dispute. While traditional theory assumes economic agents to be fully rational, Behavioural Finance assumes them to be normal in the sense that they are subject to typical human decision biases that were demonstrated for a wide range of individuals in general. This dialectic can, however, be resolved if a clear distinction between traditional normative and descriptive behavioural research is made. In the remainder of the chapter, this review focuses on descriptive research relating to the phenomena of overconfidence and regret aversion respectively.

2.2 Overconfidence in financial decisions

Financial research that incorporates overconfidence is for the purpose of clarity structured here according to whether it relates to an asset market or a corporate finance context. Even though such domain related dissimilarities mean that models cannot simply be transposed to the other context, there are many ideas and insights relating to the modelling and the effects of overconfidence that are useful input at a general level. In addition, as the integration of overconfidence into finance research has largely been advanced in the past with respect to stock market investors, it is appropriate that this review should include both streams of the literature.

2.2.1 Overconfidence in financial markets

The literature on the role of overconfidence in financial markets can be further differentiated by its fundamental orientation. One strand of the literature considers the effects of overconfidence, while another deals with the question of whether and why overconfidence may survive in the market. In addition, there is empirical work to demonstrate the existence of overconfidence among market participants.

The fundamental proposition that financial analysts and traders may be overconfident is sustained empirically by Tyszka & Piotr (2002) and Fenton-O'Creevy, Nicholson et al. (2003). Tyszka et al. (2002) compare the forecasting behaviour of financial analysts to that of meteorologists for future events in their respective domains of expertise; the authors conclude that financial analysts are much more strongly overconfident. In

another recent investigation, Fenton-O'Creevy et al. (2003) investigate the illusion of control, which is closely linked to, and may thus be used as a proxy for, overconfidence. The responses of 107 traders from different banks in the City of London to a computerized test show that many of these professionals are subject to this cognitive bias, although with noticeable individual differences (Fenton-O'Creevy et al., 2003:62).

Trader overconfidence has been used by several researchers as a potential explanation of different market anomalies. For example, Daniel et al. (1998) develop a theory that can explain stock price momentum²² and long-run reversals (p.1866). Overconfident investors overestimate their ability to obtain or analyse important (private) information (p.1841), thus believing they know more or better than the other market participants do. Daniel et al. (1998) model overconfidence dynamically in the sense that an individual's confidence is influenced over time by whether his private beliefs eventually turn out to be correct or wrong (p.1856), and show how this may lead to the observed security price patterns. Odean (1998b), who analyzes the effects of overconfidence in differently efficient markets, predicts over- and under-reaction as well as higher trading volume for excessively confident investors. Clearly, both predictions have been observed in financial markets, yet there is always the question to what extent anomalies like instances of high volatility can really be attributed to overconfidence.

In view of the necessity to establish such a causal link, further empirical research to this has been reported. Empirical support for the proposition that overconfidence may lead to excessive trading is offered for instance by Glaser & Weber (2003); in their survey of 215 investors, Glaser et al. (2003) find that those individuals who consider themselves to have above average ability also trade more (p.35). In addition, Barber & Odean (2001) analyse trading account data on 35,000 households. Following findings on gender-specific differences of overconfidence in financial decision tasks, which predict that men are generally more overconfident, Barber et al. (2000:266) split their sample into men and women. The statistical analysis shows that men trade on average significantly more than women do, a finding that is interpreted as supporting the hypothesis that overconfidence leads to active stock dealing.

²² Positively or negatively serially correlated stock price returns.

One question that necessarily arises from these studies is how the effects of overconfidence are to be evaluated. A priori, one is inclined to view any deviation from rational choice as sub-optimal and be driven to suggest ways in which stock investors can overcome overconfidence. Overconfidence is detrimental for the individual trader in many contributions. In Barber et al. (2001), men, who are generally more overconfident than women, trade more but achieve lower returns. In an earlier article, Barber & Odean (2000) analyse a data set consisting of trading information of more than 60,000 households obtained from a large US brokerage house. Households that trade more often experienced on average a lower net annual return on their portfolios; just holding the stocks would have been better (p.786). So why do households not just buy and hold? Barber et al. (2000) propose that the overconfidence hypothesis may partly explain this behaviour (p.794). Similarly, Biais, Hilton et al. (2002) obtain results that are supportive of hypotheses that overconfident investors are less successful. Based on the data of 184 experimental subjects who participated in a trading simulation, Biais et al. (2002) find a relationship between participants' measured overconfidence and losses (p.16). Faced with these hypotheses, and in a spirit of helping, Baker & Nofsinger (2002:112) even suggest ways for investors to overcome psychological biases.

However, as many critics of Behavioural Finance would also point out, if overconfidence were indeed to affect investing in a way that tends to result in a bad performance, one might expect overconfident traders to be driven out of the market by rational investors and by the forces of arbitrage. This very argument, namely that overconfident market participants will be eliminated by the market forces, is addressed by Kyle & Wang (1997). The authors propose a model where one stock market trader may have a biased belief regarding the precision of his expectations. Upon receiving a good signal, the overconfident trader will buy more than a rational agent. Due to this difference in the holding quantity of an asset, overconfident traders may outperform rational colleagues, and may hence survive in the market (Kyle et al., 1997:2086). The persistence of overconfident traders is furthermore endorsed by DeLong, Shleifer et al. (1990) who, following a very similar line of argument, suggest a model in which overconfident traders can have higher expected returns because they tend to hold more of the risky asset. Greater risk taking is also the reason why overconfidence might persist according to Hirshleifer & Luo (2001), Wang (2001), as well as Daniel,

Hirshleifer, & Subrahmanyam's (2001) model where arbitrageurs are assumed to be risk-averse (p.3).

Under this logic, overconfident traders who survived for some time must necessarily have been rather successful. This past success can then in the sense of a vicious circle ensure that overconfidence will survive for even longer: As Gervais & Odean (2001) propose, overconfident and successful traders have accumulated enough wealth to be relatively safe from being driven out of the market quickly so that overconfidence can survive (p.20). This dynamic model by Gervais et al. (2001) is interesting because it not only assumes that successful traders may become overconfident when they underestimate the role of luck and give all credit for their own success to themselves, but also because it suggests that despite these causes for overconfidence, the bias may still be gradually eroded over time with increasing experience (p.11). However, by way of contrast, experimental evidence reported by Kirchler & Maciejovsky (2001) suggests that overconfidence may also increase with trading experience for quite some time.

The overall perspective on overconfidence in financial markets is thus that it may lead to excessive trading and volatility, and predictable stock price patterns, and may be generally detrimental to performance. The empirical evidence collected so far suggests that over- and under-reaction as well as excessive stock dealing is value destroying, as for example overconfident individuals lose out by trying to 'beat the market', and several models have been proposed to explain this. However, the argument of whether and why overconfidence may exist in financial markets quickly leads into a discussion about the limits to arbitrage, and the question whether financial markets are efficient or not; a discussion that is not immediately relevant to the proposed research, though. For even if overconfidence is eventually eliminated in financial markets, on place where it may well endure quite some time is at the level of a corporate manager. There are several reasons to assume that individual managers are able to be overconfident without being eroded quickly (Heaton, 2002: 34). The following section reviews the literature in Behavioural Corporate Finance that incorporates investor overconfidence.

2.2.2 Corporate finance decisions with overconfidence

There are two approaches to studying the effect of non-rational behaviour on corporate finance decisions. The first approach assumes that it is investors who are biased, with managers being rational but having to cater to investor demands (Baker & Wurgler,

2002). Seemingly anomalous investment decisions are thus explained as (rational) responses to imperfect markets. Empirical support to the notion that stock market mispricings influence corporate investment decisions is provided for instance in Gilchrist & Himmelberg (2002). Models of how managers should react to share equity mispricings are offered by Blanchard, Rhee, & Summers (1993) and Stein (1996). As an example, in Stein's (1996) model, stock market investors make errors in forecasting the returns of individual stocks so that a company's shares may be over- or undervalued (p.432). Stein (1996) seeks to determine how an appropriate discount rate can be established in such a context, given different managerial time horizons (p.433). A drawback of this approach, however, is that even though it relates to corporate finance decisions, it assumes again inefficient stock markets rather than only biased managers. As a consequence, as interesting as this first approach in behavioural corporate finance theory may be, it is not directly relevant to the present research and shall thus not be discussed further.

Closest to the present research is therefore the strand of corporate Behavioural Finance literature in which the *individual* manager is assumed to suffer from psychological biases. As far as managerial overconfidence is concerned, perhaps the earliest contribution in this field is Roll's (1983) 'hubris hypothesis'. Hubris²³ can be interpreted as another term for overconfidence. Roll analyses the case of take-over bids, and in particular the observation that the bidding price in such transactions typically contains a premium to the target company's market value. Managers who believe that the market is wrong and that they know better how much the target is worth are hypothesized to be overconfident by Roll (1983:200). A similar line of argument can also be found in Duhaime & Schwenk (1985) who discuss the role of the illusion of control in a mergers and acquisitions (M&A) context. An attempt to investigate the role of managerial beliefs for corporate acquisitions is undertaken by Boehmer & Netter (1997). The authors use managers' trading in their own stocks as a proxy for optimism and investigate if there are changes in this around acquisitions. Boehmer et al., 1997:694). The fact that they fail to make out any significant effects may (p.703), however, also be attributable to external factors such as legal restrictions on insider trading, a concern that the authors briefly attend to themselves (Boehmer et al., 1997:695).

²³ The Greek term hubris translates as arrogant pride or presumption according to the Oxford Dictionary.

The role of overconfidence has also been studied in the area of capital structure decisions (Hackbarth, 2002; Fairchild, 2005), and the paper by Heaton (2002) also makes some predictions for a preference order of financing instruments when a manager is overconfident in the sense that he thinks the market is not correctly appreciating his company's value. Given the focus of my research, however, of the greatest relevance here is the literature that studies the role of overconfidence in a capital investment decision context. The emphasis is thus placed on these contributions. Following the identified structure of the capital investment decision process as consisting of three essential steps, project selection, managerial effort and project evaluation, the review of this core body of knowledge maintains this structure.

Investment project selection

The first step of the capital investment decision process is defined as relating to the decision problem of whether to accept or reject a given investment. This decision ought to be made rationally, based on the expected net present value of the investment. Due to the uncertainty of future cash flows, a key challenge of the project selection decision is formulating forecasts. Subjective forecasts depend on managerial expectations. However, overconfidence may bias these expectations about the future by making a task seem more controllable than it is and by marginalising any potential noise or error component, and these effects are also seized upon by articles on the role of overconfidence in project selection. For instance, in Heaton's (2002) model, overconfident managers "systematically attach too much probability to good outcomes and, correspondingly, too little probability to bad outcomes" (p.37). Due to such biased forecasts, the expected value of any project will be overstated and thus investments that have an objective negative NPV may seem to the overconfident manager to be a worthwhile investment. Consequently, in some cases, overconfident managers may accept a 'bad' investment project (Heaton, 2002:41) crediting it with more upside potential than is warranted for by rational expectations.

Heaton (2002) further proposes that overconfidence may also lead a decision maker to turn down an investment with a positive NPV. This situation may occur when there is insufficient free cash flow to finance the project internally. Because of his overconfidence, the manager feels that the stock market is not giving credit to his company's prospects and that as a consequence the cost of equity is understated (Heaton, 2002:38); he will thus assume a cost of equity he believes to be more

accurate, which is by definition higher than the actual one (p.38). As a result, an investment may appear not to have a positive NPV although it objectively has (p.40). The overconfident manager may thus turn down an investment even though it should be accepted based on an objective and rational assessment. In Heaton's (2002) model, the effect of overconfidence is thus indeterminate a priori, and depends on the degree to which internal financing is available²⁴. Overconfidence may lead managers to accept projects with a negative NPV, but also to reject investments that a rational agent would accept since they have an objective positive NPV. A testable prediction of the model is therefore the proposed relationship between managerial confidence levels and the cash flow sensitivity of capital expenditure.

Precisely this hypothesis is investigated by Malmendier & Tate (2001). Specifically, the authors investigate whether overconfidence can explain the cash flow sensitivity of capital expenditure that is observable in reality. In order to determine whether a manager is overconfident, Malmendier et al. (2001) examine data on managers' personal portfolio strategies. A manager is characterized as overconfident if he regularly failed to exercise stock options on the firm's equity even though they were in the money (Malmendier et al., 2001:15) and if he is a habitual (net) buyer of his own company's shares (p.23). The researchers find that capital expenditure is more sensitive to cash flow in companies where managers are characterised as overconfident. This result is interpreted as supportive of Heaton's (2002) claim that overconfidence does influence investment project selection as a function of the availability of internal funding. Malmendier et al. (2001) are among the first to publish empirical research on managerial overconfidence in an investment decision context. Their work thus represents an important contribution. However, overconfidence is only inferred using secondary data in their research, as opposed to being directly observed. Another possible limitation is that their data does not allow Malmendier et al. (2001) to differentiate between different degrees of overconfidence, reducing it to a binary variable.

While the models by Heaton (2002) and Malmendier et al. (2001) are static, a dynamic model of corporate investment decisions incorporating overconfidence is proposed by Gervais, Heaton, & Odean (2003). In this three-period model, the manager can either

²⁴ With its emphasis on the role of internal financing, Heaton's (2002) model can be compared to Jensen's (1986) and Myers & Majluf (1984).

accept a project immediately or wait for further information (p.7). New information on the project becomes available at the end of each period in the form of a noisy signal. Overconfidence is modelled as an overestimation of the precision of this signal (underestimation of the noise). Given a good signal, the overconfident manager will overestimate the probability of a good outcome and, ultimately, the project's NPV (Gervais et al., 2003:14ff). The challenge for the manager resides in the fact that a project may cease to exist during the process, thus creating a cost associated with delaying investing to acquire further information. Gervais et al. (2003) contrast the behaviour of an overconfident manager in this trade-off against that of an unbiased risk-averse agent. They conclude that overconfident managers accept investment projects more quickly than their risk-averse counterparts (p.27) do. In addition, similar to Heaton (2002), overconfidence may also lead managers to accept investments that have an objective negative NPV (Gervais et al., 2003:28).

Managerial effort

The second decision step in capital investment decision making was defined as the manager's choice of effort. Concerning this optimisation problem, the question arises whether overconfidence might lead to a higher or lower equilibrium level of effort. Intuitively, one may be inclined to suggest that feeling too sure about success should lead to lower effort; just as a pupil who overconfidently believes that he will have no problem in the next exam might be tempted to prepare less for it than would be optimal. Stone (1994), reporting observations from an experiment where positive expectations were induced in an effort level decision, notes that "conditions which create complacent self assurance provide few incentives for exerting [high effort]" (p.471). Based on Stone's measure of effort, the subjects with strongly negative expectations worked hardest in his experiment (Stone, 1994:465). Consistent with this is also a result of research by Cooper, Folta, & Woo (1995), who investigate the extent to which entrepreneurs search for information prior to investing in a new venture. The authors conduct a survey in which they also measure respondent's overconfidence (Cooper et al., 1995:112). Their analysis of the over 1,000 responses from US entrepreneurs leads Cooper et al. to conclude that "those who were more confident searched less intensively" (Cooper et al., 1995:117).

In contrast to these empirical findings, more recent theoretical models predict that overconfidence should be associated with greater effort. Richard Fairchild (2004)

proposes a simple and perceptive model of managerial effort in the presence of moral hazard. The interesting aspect of his model is that overconfidence is interpreted closely with the existing literature in psychology as the manager's exaggerated view of the impact of his effort contribution. It is hence through believing that his effort can affect the probability of success in an investment project by more than it really does that the manager becomes overly optimistic. Fairchild's (2004) model also considers framing, and places the managerial decision in a principal-agent framework, which distinguishes between shareholder value and the manager's pay-off. Regarding managerial effort, the prediction of this model is that overconfidence should result in greater effort provision (Fairchild, 2004:18).

This prediction is consistent with other research on managerial effort. In Besharov's (2002) model, the overconfident individual overestimates the value enhancing effect of his actions (p.8). Accordingly, the subjectively perceived ratio between the benefit and cost of effort is biased, causing an overprovision of effort. Further, the paper by Keiber (2002) also connects an agency model (hidden action) with the finding that people are overconfident. Different to Fairchild (2004), in Keiber's model both the agent and the principal are overconfident. The manager receives a noisy signal relating to the future state of the economy; overconfidence leads the manager to overestimate the quality of the signal (Keiber, 2002:6). In negotiating his salary, the overconfident manager will more readily accept a contract with a high variable compensation component, given a good signal (p.20). In this setting, overconfidence is also predicted to lead to greater managerial effort (Keiber, 2002:23). However, the empirical evidence cited by Keiber seems to suggest a different, inverse, relationship between overconfidence and effort.

Investment project evaluation

The project evaluation decision is the third and final step of the capital investment decision process as it is defined for the present research. Surprisingly, given the importance of this decision task, the role of overconfidence in the decision whether to continue or abandon an investment seems to be largely unexplored as of yet. The only corporate finance contribution that the present author is aware of is the theoretical analysis by Richard Fairchild (2004). However, in addition to overconfidence, Fairchild's model also features other psychological phenomena, namely framing and mental accounting. The model consists of three periods. Following the initial investment decision, the investment can turn out at a gain or at a loss. In the case

where the project failed and is loss making, the manager can decide whether to continue or abandon the project; under continuation, the investment could still be profitable in the third period, but it could also have a cash flow of zero, whereas abandonment will result in a small but positive cash flow (Fairchild, 2004:13). The model illustrates that overconfidence may strengthen the tendency of framing and mental accounting to lead the manager to over-commit by continue investing in a losing project (Fairchild, 2004:18). Although this prediction receives some support from psychologists Kahneman & Tversky (2000a:477), the body of literature in behavioural finance is somewhat deficient on this topic.

2.3 Regret aversion in the finance literature

As defined in the preceding chapter, aversion to regret is a psychological phenomenon that makes people consider the potential disutility of anticipated regret associated with outcomes in their assessment of choice alternatives. At least by some academics in Finance, the potential significance of regret aversion has been recognized:

"Hope and fear might be the strongest emotions that drive [...] stock traders, but regret is not far behind" (Statman, 2001:9).

Despite such observations by distinguished scholars, very limited attention has been given to regret aversion in the existing Behavioural Finance literature so far. In the following, I review the most prominent contributions in this area.

2.3.1 Regret aversion in financial markets

One widely recognised application of regret theory to stock investment is the paper by Shefrin & Statman (1985). This article investigates the tendency of individuals to hold on to assets that are falling in value (p.778). Already Kahneman et al. (1979) had observed the unwillingness of individuals to realize (book) losses and termed this phenomenon loss aversion, which is also a central feature of their prospect theory. Shefrin et al. (1985) propose an advanced theory to explain this well-documented puzzle, termed the disposition effect, namely that investors appear to realize gains quickly by selling 'winning' shares too early, whilst holding on to losing stocks for too long (Shefrin et al., 1985:788). The authors conjecture that such behaviour is best accounted for by a decision making framework integrating several predispositions of

the human mind, including regret aversion: “Aversion to regret provides an important reason why investors may have difficulty realizing gains as well as losses” (p.778). The authors consider regret to be the chief driver behind the disposition effect: “the quest for pride, and the avoidance of regret lead to a disposition to realize gains and defer losses” (Shefrin et al., 1985:782).

Another, more recent contribution that makes theoretical predictions about the effect of regret aversion in a financial market setting is the paper by Anna Dodonova (2001). She finds that regret aversion in investors may explain the equity premium as well as the high volatility of stocks. In her model, excessive volatility is explained as an overreaction to good news about a stock. Regret-averse investors try to minimize the potential regret of having lost out on a winner by buying even more shares following the recent positive development; this higher volatility leads to a higher equity premium demanded by the risk-averse investors (p10). Unfortunately, the model by Dodonova (2001) is not extended to cover the situation where share prices are falling. Hence, no predictions about the effect of regret aversion in the case of prior bad news are made, and the model is only of limited applicability to my research.

2.3.2 Corporate finance decisions with regret aversion

Fisher & Statman (2003) explore the role of currency hedging for international portfolios. For portfolios over the period from 1988-2002, they show that unhedged portfolios were characterized by roughly the same risk and return as hedged portfolios (p.8). Whilst rationally, agents should thus be fairly indifferent between hedged and unhedged portfolios, Fisher et al. (2003) note that in practice this is not the case; in fact, investors tend to switch back and forth between the two types of portfolios (p.9). The authors propose that this can best be explained through the regret aversion of investors:

“Behavioral investors follow a cycle of hindsight and regret where they conclude, with hindsight, that they could have seen with foresight the securities that would make them rich, and suffer the pain of regret because they did not” (Fisher et al., 2003:6).

Most immediately relevant to my research is the article by Statman et al. (1987), in which the authors apply regret aversion directly to corporate investment decision making. In their analysis, an investment project has failed. Because the decision maker cannot ignore the sunk costs of a project, termination would induce feelings of loss and

regret; because of mental accounting and framing, the pain of regret is only really felt when an investment is terminated and the loss is “admitted as a fact” (Statman et al., 1987:12). As a consequence, money-losing investments are continued in order to delay experiencing the regret (p.14). According to Statman et al., this tendency to continue losing investments is greater when the decision maker is personally committed to the project. Given a focus that is identical to parts of my research, it is worth outlining the ways in which my research is different from and adds to this paper by Statman et al. (1987).

Statman et al. assign a key role to the concept of sunk costs, and also draw on the concepts of mental accounting and framing. As a result, their proposed explanation is quite complex and does not make entirely clear the role of regret aversion. Moreover, a clear definition of regret is missing. Finally, their conclusion that the aversion to regret leads to inefficient continuation of an investment seems to assume that an individual may expect the pain of regret to be lower if it is realized in the future; again, though, no formal illustration of this conjecture is provided. In contrast, my research studies regret aversion in capital investment decisions (including the abandonment / continuation decision) in isolation to make clear predictions on the effect of this bias without drawing on other phenomena. Further, my definition of regret is derived directly from the Psychology literature, and I also substantiate my predictions using a formal model.

When looking for empirical data to support the regret aversion hypothesis for late project abandonment, the first problem one has to deal with is to find out whether a project was abandoned late or on time. Statman & Sepe (1989) tackle this issue by looking at stock market price movements following project termination announcements. They develop the argument that termination announcements, which are good news to shareholders and thus lead to a rise in the share price, are inconsistent with the normative abandonment rule, unless a new and better project is announced simultaneously (p.2). However, high stock returns following a termination announcement can be consistent with the late project abandonment hypothesis (p.2). The analysis of their data set shows that “on average, shareholders consider project termination announcements good news” (Statman et al., 1989:80). According to Statman et al. (1989) this means that shareholders must have realized that managers were throwing ‘good money after bad’ and had put a discount on the shares for this; with the project terminated, there is an end to the cash drain and hence the share price

recovers to some extent. However, whilst the evidence by Statman et al. (1989) supports the claim that managers may often continue an investment for too long, it does not succeed in linking this observation to regret aversion.

2.4 Summary

The aim of the present research is to identify the effect of managerial overconfidence and regret aversion on capital investment decisions, and to assess if this effect is desirable from a shareholder value point of view or not. To this end, the purpose of this chapter was to consider the existing research that has at least addressed some of the issues relevant to this research. The reviewed contributions can largely be attributed to the field of behavioural finance, the discipline within finance research that seeks to integrated findings from psychology about how people make decisions under uncertainty. By way of summarizing the literature review, it appears that overconfidence may lead to over-investment, greater or lower effort, and investment project escalation. Concerning regret aversion, the existing body of literature in behavioural finance is even more limited, and essentially, there only seems to be a belief that regret aversion may lead managers to abandon losing projects too late. What the literature review has shown clearly, however, is that our understanding of the role of human psychology in managerial capital investment decisions is deficient in many respects, and that the present research, with its aim of contributing to filling this gap in knowledge in what is a rather recent but quickly developing area of research is useful and necessary. In the next chapter, I address this perceived necessity by proposing a theoretical model covering the three identified capital investment decision steps, and show how predictions about the effects of managerial overconfidence and regret aversion on those decisions can formally be derived

CHAPTER 3: MODEL AND PROPOSITIONS

The central question driving my research is what effect(s) overconfidence and regret aversion may have on managerial capital investment decisions, and how this may affect shareholder value. Since the existing literature as reviewed in the preceding chapter does not respond to this question satisfactorily, I propose a new theoretical model integrating the project selection, effort level, and project evaluation decisions. The set-up of the model is such that it is possible to integrate overconfidence, regret aversion, or both, in a consistent manner into the analysis across all three decision problems. Without the biases, the model is used to describe normatively optimal (rational) decision behaviour. Including the biases will allow making predictions of how an overconfident or regret-averse decision maker would behave. The model thus permits contrasting behaviour ‘as it is’ (affected by cognitive biases) with behaviour ‘how it should be’ (given the optimality of rational decision making). Prior to outlining the model in detail, however, some general assumptions I am making here need to be mentioned.

For one, I assume the decision maker to pursue value-maximization, irrespective of whether he is assumed to be rational or biased by overconfidence or regret aversion. Hence, contrary to models of agency, the manager in my model does not pursue his own self-interest but tries his best to take decisions in the best interests of shareholders. As a result, any values or costs²⁵ in this model relate to shareholder value. However, owing to the effects of overconfidence or regret-aversion, a biased manager will not be able to evaluate choice options correctly. As a result of such flawed perceptions, despite seeking to maximise value and adhering to the net present value rule, decisions with overconfidence or regret aversion may deviate from the normatively optimal behaviour. At this point, it is worth highlighting again that the studied biases, as well as the resulting behaviour, are assumed to be unintentional. The overconfident decision maker is not aware that his forecasts are biased, they appear rational to him. To him, the fact that they may deviate from those of others just means that the others must be wrong. Similarly, an individual who incurs a strong disutility

²⁵ In particular, I model the cost of effort as a reduction in shareholder value rather than it being internal to the manager. This cost represents the opportunity cost of the manager contributing effort to this investment instead of another project.

from experiencing regret does not expressly reduce the values of outcomes by the related anticipated amount of regret; outcomes simply appear to him as being objectively that desirable or undesirable.

Further, as noted in Chapter 2, different possible assumptions about individual risk preferences exist. Under the standard rational choice paradigm, individuals are assumed to be risk-averse based on the concavity of the utility function. Yet in the literature, the decision agent is frequently modelled as being risk-neutral. Risk-neutrality is also assumed in the model presented in this chapter. Although this supposition may be considered as somewhat of a departure from descriptive accuracy, I argue that the benefits of this modelling convention outweigh its disadvantages. In particular, assuming a risk-neutral decision maker greatly reduces the complexity of the analysis. In that respect, models are like maps – they need to be reductions of reality in order to be useful. A further benefit from assuming risk-neutrality is that expected monetary outcomes are interchangeable with expected utilities. At the same time, the assumption of risk-neutrality is not likely to have a material effect on the basic direction of the predicted behavioural tendencies. The general behavioural tendency of the modelled biases is essentially independent of assumptions about risk preferences²⁶.

The chapter proceeds as follows. First, I present my model of the capital investment decision process. I then explain my approach to modelling overconfidence and regret aversion. This formal representation is developed based on the reviewed literature in psychology and behavioural finance. The third part of the chapter is then dedicated to solving the decision choice model by backward induction. There are thus three sections in which the effects of allowing the parameters for individual overconfidence, regret aversion or both to vary are formally analysed for project selection, managerial effort and project evaluation. By varying one bias and holding everything else constant, I can make predictions about the effects of overconfidence and regret aversion individually, while predictions for the joint effect can be obtained when both the overconfidence and the regret aversion parameters are allowed to vary. Based on an analysis of critical 'turning-points', the impact of these decision biases on observable behaviour is then finally proposed.

²⁶ Risk preferences are, however, relevant in the assessment of the desirability of the biases for shareholders, but this issue will be discussed later.

3.1 A model of the capital investment decision process

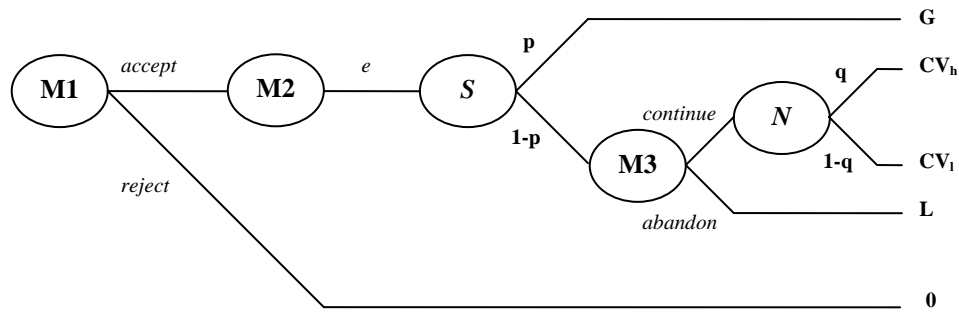
Consistent with the earlier definition of the capital investment decision process, the model consists of three consecutive managerial decision stages: Project selection [M_1], managerial effort choice [M_2], and project evaluation [M_3]. The sequence of events in this model is as follows.

- **Period 1:** Assume a given investment opportunity has arisen within a company. The manager needs to decide whether to accept and invest in the project, or whether to reject the proposed investment, based on his appraisal of the investment. The investment is rejected if it has a negative NPV [$\hat{V} < 0$], and accepted otherwise. If the investment is rejected, the game ends and no value has been created or destroyed.
- **Period 2:** If the investment is undertaken, the manager decides in the second time period how much of his energy, time and resources he wants to put into the management of the investment project. I assume this effort level [e] to be a continuous variable with [$0 \leq e \leq 1$].
- **Period 3:** At a given milestone in the project, the manager receives information about the investment's performance in the form of a reliable signal [S], which can be either good or bad. Following a good signal, which occurs with probability [p], the investment achieves a positive net present value [$G, G > 0$] and the model ends. This probability of success is assumed to depend in part on managerial effort. In contrast, if the bad signal was obtained, with probability [$(1 - p)$], the investment is assumed to be underperforming, having lost more cash than expected. The manager is faced with the third decision problem, project evaluation, and has to choose between continuation and abandonment of the investment. If the investment is terminated, a negative NPV – the termination value [$L, L < 0$] – is realised. In reality, this value may be known (ex-ante) with certainty, but may also be subject to some uncertainty²⁷. To keep the model simple, however, it shall be assumed in the ensuing analysis that the termination value is known in advance.

²⁷ Early termination of the investment might require for instance in some cases contractual penalty payments, the amount of which may depend on court settlement, so that the abandonment value is à priori not certain.

• **Period 4:** If continued, the eventual value of the investment depends on the realization of a state of nature $[N]$ that is beyond the control of the decision maker, such as the price for crude oil. Depending on the output of this chance event, either a non-negative (high) or a negative (low) continuation value (with $CV_h < G$, $CV_l < L$) can be realised with probabilities $[q]$ and $[1-q]$ respectively²⁸. The entire capital investment decision process is illustrated by the diagram in Figure 3.1.

Figure 3.1: Capital investment decision model – Decision tree diagram



3.2 Formal representation of overconfidence and regret aversion

In order to analyse the effects of overconfidence and regret aversion at all three decision steps, I propose a formal way of integrating these two biases into the decision model in line with the reviewed literature. Both overconfidence and regret aversion are built into the model as continuous variables defined over the range $[0;1]$ to allow for individual differences in either bias. The way in which the two phenomena are represented is consistent throughout the analysis and presented in the following.

3.2.1 Overconfidence

Overconfidence was defined as describing the human tendency to overestimate one's knowledge and ability, one's relative skilfulness, and the quality and reliability of one's own information. Given the different symptoms of overconfidence, there are several ways in which this bias may be formally modelled. Where it is analysed in a financial markets context, overconfidence is typically interpreted as relating to the accuracy of information that frequently is modelled as a noisy signal (e.g. Daniel et al.,

²⁸ Note that these probabilities are assumed not to depend on the decision maker's effort.

1998). Due to overconfidence, the individual receiving such information believes it to be more reliable than is warranted for and thus under-estimates the signal's variance. This approach is adopted for instance by Gervais et al. (2003) and Keiber (2002). As a result, the individual tends to over-react to new information (Odean, 1998b). However, whereas such an interpretation of overconfidence may be suitable to stock market investment, it appears less pertaining to an analysis of corporate capital investment. Consequently, my modelling of managerial overconfidence builds on an alternative way of accounting for this bias proposed in recent research in behavioural corporate finance.

Two different situations are to be distinguished in this context, depending on whether the (uncertain) outcome of a decision can or cannot be influenced by the manager. The case where the outcome of the investment *can be influenced* by the manager (through his effort) is assumed in the model by Richard Fairchild (2004). Here, overconfidence in his ability makes the manager believe that he has greater control over the chance with which an investment will be successful than he actually has. Specifically, Fairchild (2004) models the success probability as a function of effort, where overconfidence leads to an over-estimation of the extent to which effort can influence the probability. As a result, the overconfident manager believes that for a given level of effort, success is more likely than it really is. This type of overconfidence, overconfidence in ability, is relevant to the first state of nature in my model, where, following the effort level decision, the information on the investment's performance can be either positive with probability $[p]$ or negative with probability $[(1 - p)]$.

It is assumed that this probability is the realisation of an externally given probability distribution that is unknown to the decision maker. However, since this probability is unknown, it must be estimated ex-ante. In order to describe the benchmark of optimal behaviour, I assume that the probability of success is correctly anticipated by the manager in the absence of any bias. Hence, the ex-ante unknown ('true') probability of success is defined through the rational expectations of an unbiased agent of that probability such that:

$$(Eq-3.4) \quad p = \hat{p}_{rational} \quad \text{with} \quad p \in [0;1]$$

Following Fairchild (2004), the rationally expected probability of success depends partly on managerial effort such that

$$(Eq-3.5) \quad p = \gamma \cdot e \quad \text{with} \quad \gamma, e \in [0;1]$$

The effort coefficient $[\gamma]$ represents the degree to which the manager can affect the probability of success. The coefficient may thus be interpreted as the weight assigned to effort as opposed to pure chance in the equation of the success probability. Given this definition of $[p]$, the manager is able to positively influence the odds with which the investment will be successful by working harder (providing greater effort) $[e]$, but only to the extent $[\gamma]$. As in the model by Fairchild (2004), I introduce overconfidence in this case as a biased perception of the effort coefficient $[\gamma]$. Specifically, overconfidence is represented by the coefficient $[a]$ with $[a \in [0;1]]$. The coefficient is increasing in individual overconfidence and reaches a maximum for $[a = 1]$, whereas a value of zero $[a = 0]$ indicates the absence of individual overconfidence (well-calibrated decision maker). With overconfidence in ability, the subjectively expected probability of favourable information received in period 3 is thus given by

$$(Eq-3.6) \quad \hat{p}_{oc} = \gamma^{(1-a)} \cdot e$$

It follows that overconfidence in ability always leads to an overestimation of the probability of success such that

$$(Eq-3.7) \quad \hat{p}_{oc} > p \quad \text{for all} \quad a > 0$$

In contrast to the case described so far, there are also situations in which the success probability *cannot be influenced* by the manager. For these types of decisions, the realisation of a particular outcome depends entirely on chance and is external to the control of the manager (state of nature event). In my model of the capital investment decision process, the outcome of continuation of the investment depends on the state of nature (period 5). Here, all the decision maker can do is formulating an estimate for the probability of the good state occurring. It is assumed again that an objective probability for the good state of nature exists and that it is defined by the notion of rational expectations akin to (Eq-3.4):

$$(Eq-3.8) \quad q = \hat{q}_{rational} \quad \text{with} \quad q \in [0;1]$$

Since in this case the state of nature cannot be influence by managerial effort, overconfidence in ability does not affect the manager's estimate. However, following Heaton (2002) and Gervais et al. (2003), the overconfident manager still holds a positively biased view of the chance with which the good state of nature will occur. In this situation, the individual's expectations are biased by the unfounded optimism that

was identified in the literature review as a central feature of managerial overconfidence. This type of overconfidence, referred to here as overconfidence in the state of nature or optimistic overconfidence, is modelled as an overestimation of the probability of success, when the outcome cannot be controlled, by the coefficient $[b]$ with $[b \in [0;1]]$:

$$(Eq-3.9) \quad \hat{q}_{oc} = q^{(1-b)}$$

In the absence of overconfidence $[b = 0]$, the probability for the good state of nature will be correctly estimated; with increasing overconfidence, however, the subjective probability estimate will be too optimistic, hence

$$(Eq-3.10) \quad \hat{q}_{oc} > q \quad \text{for all} \quad b > 0$$

In this analysis, and consistent with the literature (e.g. Griffin et al., 1996), I thus distinguish between two types of overconfidence, overconfidence in ability and overconfidence in the state of nature. Both are modelled similarly and lead to an overestimation of the probability with which the investment will achieve the better of two possible outcomes. Although treated separately in the model, it should be noted that in reality, it is unlikely that one may exist without the other (see earlier discussion in Section 1.2.3). What may thus be a somewhat artificial separation benefits the analysis in terms of clarity, but will not be upheld in further empirical work where it shall simply be assumed that $[a = b]$ ²⁹.

3.2.2 Regret aversion

The second behavioural component in my analysis is aversion to regret. If an individual regrets a decision, the satisfaction derived from the associated outcome is reduced by the disutility of regret. Regret-averse behaviour consists of anticipating the disutility of any potential regret and including this in the evaluation of choice alternatives. Regret aversion has so far received much less attention in Behavioural Finance than overconfidence, and as a consequence, no specific modelling approaches exist to be built on. Therefore, with my modelling efforts entering almost untrodden

²⁹ This equality is a logical conclusion from the understanding that overconfidence in ability and optimistic overconfidence are indeed the same as they both represent an individual's degree of overconfidence (generally). The distinction between these 'two sides of the same coin' is done merely for clarity of the theoretical analysis, akin to Gervais et al. (2003).

ground, I revert to the original definitions of regret and regret aversion in Psychology. Bell (1982) proposes to measure regret as “the difference in value between the assets actually received and the highest level of assets produced by other alternatives” (p.963).

Hence, following Bell, I define anticipated regret as the difference between the expected value³⁰ of the chosen option $[\hat{V}_{i,S_i}]$ and the highest possible outcome expected obtainable with an alternative choice $[\hat{V}_{opt,S_i}]$ under the given state of nature $[S_i]$, or

$$(Eq-3.11) \quad \hat{R}_i = \hat{V}_{i,S_i} - \hat{V}_{opt,S_i} \quad \text{where } \hat{R}_i < 0 \text{ since } \hat{V}_{opt,S_i} > \hat{V}_{i,S_i}$$

Note that in my models regret will only exist over a negative range of values because regret is a disutility. Positive values for $[\hat{R}_i]$ would correspond to positive feelings such as joy or pride. Since these emotions are excluded from my analysis, I assume that there will simply be no regret if the foregone outcome is inferior to the one realised, given the state of nature. In my models, anticipated regret thus always reduces the expected value of a choice option. The extent to which it does so, however, is assumed to be different for different individuals. I assume that people have something like an individual propensity to suffer from the negative emotion regret. This regret aversion factor is presumed to be stable over time, even though casual observation might suggest that in reality this inclination to think about and suffer from what might have been may change in the course of a person’s lifetime. A person’s effective disutility due to regret aversion $[P_i]$ is thus assumed to depend upon the size of the expected regret $[\hat{R}_i]$, and the individual’s regret aversion tendency $[r]$:

$$(Eq-3.12) \quad P_i = r \cdot \hat{R}_i \quad \text{with } r \in [0; 1]$$

In normatively optimal decisions, anticipated regret is irrelevant. This will be modelled by not including the disutility of regret in the value function. Alternatively, one might also think of the decision maker as the ‘homo oeconomicus’ taking the decision, who would have a propensity to feel regret of zero $[r = 0]$. Aversion to regret, then, is reflected in my model by the regret-averse manager ranking choice alternatives based

³⁰ Since my model assumes risk-neutrality, the notions of utility and monetary value can be used interchangeably.

on their expected net value contribution *including* any potential disutility from anticipated regret, and hence indicated by $[r > 0]$.

In the remainder of this chapter, the presented model of the capital investment decision process is solved by backward induction³¹. The following analysis is hence structured according to the three identified decision steps of project selection, managerial effort, and project evaluation – albeit in reverse order, following the logic of backward induction. At each stage, the optimal behaviour will be determined first (as a type of benchmark) before considering the effect of overconfidence and regret aversion.

3.3 Solving the model

In this section, I solve the capital investment decision model proposed earlier. The model is solved by backward induction: This means that for a given investment, I first consider the evaluation decision problem (continuation or abandonment) assuming that the investment was accepted, effort was exerted, and the negative signal was received. The analysis then moves to the effort decision and solves for the subjectively perceived optimal level of effort given the decision at the evaluation stage. Finally, given the evaluation decision and the effort level, I analyse the project selection decision. For all three decision steps, the optimal decision behaviour is determined by assigning neutral values to the parameters for overconfidence and regret aversion $[a, b = 0; r = 0]$. By allowing one of the coefficients to differ from zero, I make predictions for the individual and combined effects of managerial overconfidence and regret aversion.

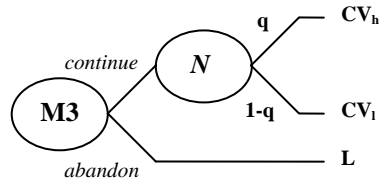
3.3.1 The project evaluation decision

The project evaluation decision constitutes the third and ultimate step of the investment decision process. Project evaluation describes the choice problem a manager faces when reviewing a given ongoing investment project. Following negative feedback on the performance of the investment, meaning that the project is underperforming, the manager may either terminate the investment, resulting in a termination value $[L]$, or continue it. If continued, the outcome of the investment

³¹ Even though backward induction is typically used in games with several strategic players, it is also plausible to assume that a single decision maker will make choices with consideration of potential outcomes.

depends on the realisation of an external binary variable. With probability $[q]$, the NPV of the investment under continuation will be small but non-negative $[CV_h \text{ with } CV_h \geq 0]$, or negative $[CV_l \text{ with } CV_l < 0 \text{ and } L > CV_l]$ with probability $[(1-q)]$. Figure 3.2 shows the relevant section of the decision tree (Figure 3.1).

Figure 3.2: Project evaluation decision problem



Overconfidence and regret aversion are integrated into this decision problem following the general modelling definitions of these two psychological biases that were outlined in the preceding section. Overconfidence leads the manager to make estimates of the probability of the good state of nature with which a value of $[CV_h]$ is achievable that are biased by the degree of his overconfidence in the state of nature, optimistic overconfidence, denoted by $[b]$. Following the general definition of regret (Eq-3.11), regret in the project evaluation decision depends on whether it is expected (ex-ante) that the outcome of the alternative choice option will be observable ex-post. It is evident that the model thus will lead to different predictions regarding the effect of regret aversion depending on which assumption regarding ex-post outcome observability is made. Theoretically, it is possible to distinguish between four different cases regarding expected outcome observability:

- Only the outcome of the chosen strategy will be known, so that the outcome of the alternative choice option will definitely not be observable (no observability): In the absence of counterfactual information, there should be no regret anticipated for either choice option. This case is thus effectively identical to assuming a decision maker who does not feel regret at all.
- Whichever strategy is chosen, both outcomes (continuation and abandonment) will be observable to the manager ex-post (total outcome observability): Interestingly, for this case, the effects of regret aversion associated with either choice option exactly offset and cancel out in my model (see Appendix A).

- If continued, the abandonment value will not be observable, whilst the continuation value will be observable even if the investment is abandoned (type 1 partial outcome observability): For example, this situation may occur when the outcome of continuing the investment depends on an external and observable variable such as the price of crude oil, whilst at the same time, the abandonment value depends on a number of factors that can only be ascertained if the project were indeed terminated.
- The value of the investment if abandoned is certain and will be known even if the investment is continued, whilst the continuation value is uncertain and will not be known if the investment is abandoned (type 2 partial outcome observability): This is the case where the scrap value of an investment is known, and will be known even if the investment is continued, but where the continuation value would not be observable ex-post subsequent to termination of the investment.

As the decision tree diagram in Figure 3.2 shows, the formal analysis here will be limited³² to the second type of partial observability.

The manager will hence feel regret if he chose to continue the investment but only obtains $[CV_I]$ since he would have been better off had he abandoned the investment $[L > CV_I]$. Consistent with the definition provided in the preceding section (Eq-3.11), the amount of regret in this case – having continued when abandonment would have been better – is given by

$$(Eq-3.13) \quad R_{ct} = CV_I - L \quad \text{with } [R_{ct} < 0].$$

Assuming a risk-neutral decision maker, the investment's expected continuation value (general form) is

$$(Eq-3.14) \quad CV = q^{(1-b)}CV_h + (1 - q^{(1-b)}) \cdot (CV_I + rR_{ct}).$$

³² Focussing on this particular case limits the complexity of the model. Moreover, of the different assumptions on outcome observability, this seems to be the most reasonable one with respect to the problem of knowing the outcome of a foregone choice option: Ignoring the possibility of alternative investment opportunities that might be taken up following abandonment, the cash flow a discontinued activity is arguably at least less uncertain than that for continuation, so that assuming type 2 partial outcome observability for this analysis would appear to be plausible.

Note that in this equation an asymmetry with a bias towards the good outcome emerges. However, this is intentional and induced by the specific modelling of optimistic overconfidence as an unjustified upward bias in probability estimates (in contrast to overconfidence in ability), which is consistent with the phenomenon of overconfidence as outlined previously in the review of the literature.

○ For an **unbiased decision maker**, the bias parameters take neutral values [$b = 0$; $r = 0$] to yield the unbiased continuation value [CV_u]:

$$(Eq-3.15) \quad CV_u = qCV_h + (1 - q)CV_l.$$

Because of the assumption of type 2 partial outcome observability, the termination value of the investment is known with certainty and unaffected by the cognitive biases. Consequently, as demonstrated in the chapter on optimal investment decision making, shareholder value maximization requires an investment to be abandoned if the value expected for continuation is less than what would be achievable with termination.

$$(Cond-3.1) \quad L > CV_u.$$

The optimality of this decision rule is based on [CV_u] representing the rationally expected continuation value.

○ The **overconfident manager** believes that achieving the high continuation value [CV_h] is more likely than it really is. Given this intuition, and by considering (Eq-3.14) it can be seen that the subjectively expected continuation value is increasing in the level of overconfidence, or $\frac{\partial CV}{\partial b} > 0$, and hence $CV(b > 0; r = 0) > CV_u$; that is, an overconfident manager who is otherwise unbiased (no regret aversion) overestimates the continuation value.

○ In contrast, the **regret-averse manager**, who is well calibrated (zero overconfidence), will underestimate the continuation value since as the individual regret aversion parameter [r] becomes larger, the subjectively perceived continuation value decreases, or $\frac{\partial CV}{\partial r} < 0$, and, therefore, $CV(b = 0; r > 0) < CV_u$. Intuitively, the anticipated disutility of regret from having continued the investment and finding out

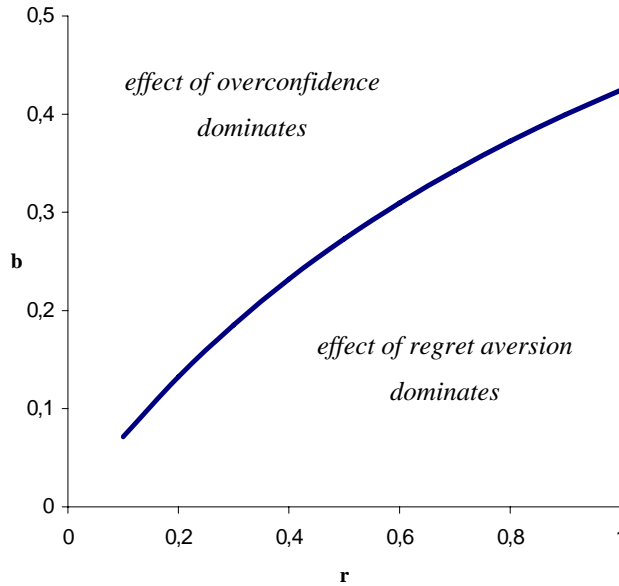
subsequently that abandonment would have yielded a higher value reduces the expected continuation value with weight $[r]$.

For the evaluation decision, the effect of overconfidence is thus directly opposite to that of regret aversion: An overconfident manager will overestimate the continuation value of an investment, whereas a regret-averse manager will underestimate it. Therefore, it is interesting to consider the interaction effects resulting from a **combination of these biases** in more detail. To do this, one may thus take any level of managerial regret aversion $[r]$ and define a critical level of overconfidence $[b']$ such that $CV(b = b'; r) = CV_u$. Solving³³ this condition using (Eq-3.14) and (Eq-3.15) for $[b']$ yields

$$(Eq-3.16) \quad b' = 1 - \log_q \left[\frac{q \cdot (CV_h - CV_l) - rR_{ct}}{(CV_h - CV_l - rR_{ct})} \right].$$

The locus of $[b'; r]$, obtained from replacing $[R_{ct}]$ according to (Eq-3.13) and different levels of regret aversion is illustrated for assumptions of $[CV_h, CV_l, L]$ in the diagram in figure 3.3.

Figure 3.3: Interaction of overconfidence and regret aversion in project evaluation



Assumptions: $CV_h=20$; $CV_l=(-30)$; $L=(-10)$; $q=0.3$;

³³ For the formal proof please refer to Appendix B.

The concave line illustrates combinations of overconfidence and regret aversion that yield the optimal decision behaviour. Any point above this line represents a situation where $[b > b']$ such that the effect of overconfidence dominates that of regret aversion, and hence that the manager overestimates the continuation value; conversely, at any point below the line, the regret aversion drives the net effect by more than off-setting the impact of overconfidence, and the manager consequently underestimates the continuation value. Based on the preceding analysis, it is possible to state a first result.

Proposition 1: *The effect of managerial overconfidence regarding the state of nature and regret aversion on the abandonment / continuation decision given that negative information on the investment's performance was received;*

(a) *If $CV = CV(b > b'; r)$, $CV > CV_u$ follows, and hence the manager overestimates the continuation value. Therefore,*

i) If $CV > CV_u > L$, the biased manager makes the efficient decision to continue the investment.

ii) If $L > CV > CV_u$, the biased manager makes the efficient decision to abandon the investment.

*iii) If $CV > L > CV_u$, the biased manager makes the **inefficient decision to continue** the investment.*

(b) *If $CV = CV(b < b'; r)$, $CV < CV_u$ follows, and hence the manager underestimates the continuation value. Therefore,*

i) If $CV_u > CV > L$, the biased manager makes the efficient decision to continue the investment.

ii) If $L > CV_u > CV$ the biased manager makes the efficient decision to abandon the investment.

*iii) If $CV_u > L > CV$ the biased manager makes the **inefficient decision to abandon** the investment.*

(c) *If $CV = CV(b = b'; r)$, $CV = CV_u$ follows, and hence the manager makes efficient continuation or abandonment decisions.*

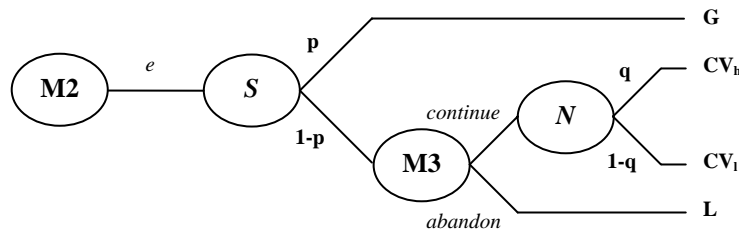
As Proposition 1(c) demonstrates, optimistic overconfidence can lead to the correct abandonment decision, but it can also lead to sub-optimal decisions that may destroy

shareholder value. Similarly, although regret aversion does not necessarily have to affect a manager's investment evaluation, Proposition 1(b) demonstrates that there are conditions under which regret aversion leads to the sub-optimal (premature) termination³⁴ of an investment. Given these individual effects, it was shown that a manager who is both overconfident and regret averse may not only over- or underestimate the continuation value, but may also arrive at the 'correct' unbiased forecast based on rational expectations. Similar to Besharov (2002), my model thus allows for the optimal behaviour despite the existence³⁵ of psychological biases.

3.3.2 Managerial effort

The analysis now moves to the effort decision. Figure 3.4 shows the part of the decision tree that is relevant to this choice problem, whereby the decision at M3 is assumed to be given.

Figure 3.4: Project evaluation decision problem



The modelling of the effort decision presented here is adopted from a principal-agent capital budgeting model by Richard Fairchild (2004) that also considers managerial effort. It is still assumed that the manager seeks to maximize the subjectively expected value of the investment, which is now a function of his effort as the probability of success [$p = \gamma e$] at this stage of the model can be influenced by the manager.

However, as outlined in Section 3.2, overconfidence biases the manager's perception of the extent to which his effort can improve the chance of success with [$\gamma^{(1-a)} > \gamma$]. The

³⁴ It must be noted, however, that this result depends on the assumption of type 2 partial outcome observability, where only the continuation value is uncertain.

³⁵ The case where the two biases exactly offset each other is probably more a theoretical solution than a likely situation in reality.

effort level decision is thus influenced by overconfidence regarding ability, which is treated separately in this analysis from optimistic overconfidence at the evaluation stage. Following Fairchild (2004), there is a cost³⁶ associated with managerial effort, which is assumed to be given by

$$(Eq-3.17) \quad C(e) = \beta e^2 \quad \text{with} \quad \beta \in \mathfrak{R}_+.$$

As there are benefits and costs associated with managerial effort, the effort choice decision represents an optimisation problem. However, consistent with the logic of backward induction, I assume that the manager sets his effort level in relation to what he expects to do at the evaluation stage; therefore, the manager will base his effort decision on whether he anticipates continuing or abandoning a given investment in the case of underperformance (negative information), and thus two different value functions need to be distinguished in analysing this maximization problem.

Eventual continuation of the investment

If the manager expects to continue the investment in the case of bad performance, the expected value of the investment for setting the effort level is simply the prospect of the two possible outcomes, $[G]$ in the case of a positive signal and $[CV]$ the expected value for continuation for a negative signal:

$$(Eq-3.18) \quad \hat{V}_{ct} = \gamma^{(1-a)} e \cdot G + (1 - \gamma^{(1-a)} e) \cdot CV - \beta e^2.$$

The level of effort that maximizes this function represents the optimal level of effort given eventual project continuation and can be written as

$$(Eq-3.19) \quad e_{ct}^* = \frac{\gamma^{(1-a)} \cdot (G - CV)}{2\beta}.$$

It can be seen from (Eq-3.18) that overconfidence affects the effort level choice in two ways. Overconfidence with regard to ability leads to a biased perception of the effect of effort $[\gamma^{(1-a)} > \gamma \text{ for } 0 < a < 1]$ and would thereby lead to higher effort if considered in isolation. Due to the logic of backward induction, however, the effort decision is also influenced by the manager's beliefs regarding the probability with which the good state of nature might obtain under eventual continuation. This type of

³⁶ While the cost of effort in Fairchild's (2004) model is born only by the manager, in my model it is assumed that the cost of effort reduces shareholder value in the sense of an opportunity cost.

overconfidence, optimistic overconfidence, induces a degree of complacency: Owing to the overestimation of the continuation value due to $[q^{(1-b)} > q \text{ for } 0 < b < 1]$, overconfidence regarding the state of nature also indirectly decreases $[G - CV]$, inducing lower effort.

The effect of regret aversion, in contrast, is unambiguous in this case given the assumptions about anticipated regret in the continuation / abandonment decision: Regret aversion was shown to reduce the expected continuation value, and hence indirectly leads to a higher perceived equilibrium level of effort.

Eventual abandonment of the investment

If the manager expects to abandon the investment in the case of bad performance, the expected value of the investment for setting his effort level is given by

$$(Eq-3.20) \quad \hat{V}_{ab} = \gamma^{(1-a)} e \cdot G + (1 - \gamma^{(1-a)} e) \cdot L - \beta e^2.$$

This equation is identical to (Eq-3.18) except for the value of the investment following negative signal with probability $(1 - \gamma^{(1-a)} e)$ which is now equal to the abandonment value $[L]$. Consequently, this maximization problem solves akin to (Eq-3.19) to yield an optimal level of effort in this case of

$$(Eq-3.21) \quad e_{ab}^* = \frac{\gamma^{(1-a)} \cdot (G - L)}{2\beta}.$$

It can be seen from (Eq-3.21) that in the case of eventual abandonment, overconfidence is predicted in my model to lead to a higher equilibrium level of effort: The effect of overconfidence in ability unambiguously increases the numerator so that $[e_{ab}^*]$ is increasing in the individual level of overconfidence. Intuitively, overconfidence leads the manager to overestimate the positive effect of his effort contribution relative to the associated cost, and thus biases this cost-benefit analysis in towards greater effort provision. Due to the earlier assumption that the termination value $[L]$ is always observable and known with certainty, regret aversion does not affect the effort decision in this case.

Proposition 2: *The effect of overconfidence and regret aversion on the manager's effort level, given the evaluation decision (continue or abandon).*

(a) *If $CV > CV_u > L$ or $CV > L > CV_u$, or if $CV_u > CV > L$, so that the manager continues the investment following a bad signal,*

i) *Overconfidence in ability induces higher effort since $\frac{\partial e_{ct}^*}{\partial a} > 0$;*

ii) *Overconfidence regarding the continuation value (optimism) induces lower effort since $\frac{\partial CV}{\partial b} > 0$ and $\frac{\partial e_{ct}^*}{\partial CV} < 0$ such that $\frac{\partial e_{ct}^*}{\partial b} < 0$;*

iii) *Regret aversion induces higher effort since $\frac{\partial CV}{\partial r} < 0$, $\frac{\partial e_{ct}^*}{\partial CV} < 0$ and,*

therefore, $\frac{\partial e_{ct}^}{\partial r} > 0$.*

(b) *If $L > CV > CV_u$ or $L > CV_u > CV$, or if $CV_u > L > CV$, so that the manager abandons the investment following a bad signal, overconfidence induces greater effort since $\frac{\partial e_{ab}^*}{\partial a} > 0$.*

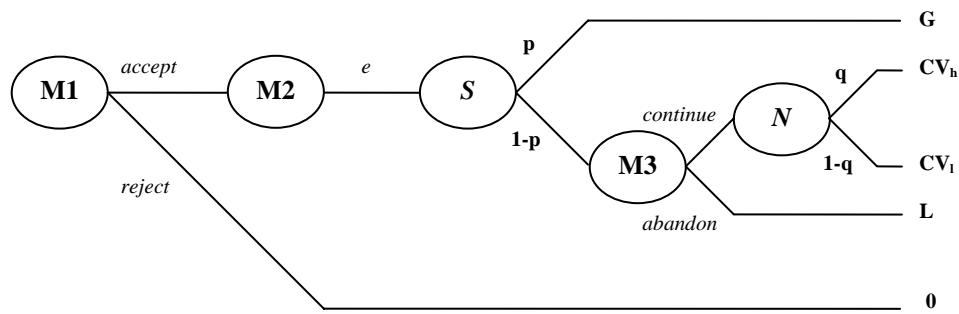
Note that the effect of the manager's biases on his decision to continue or abandon has already been given in proposition 1.

One of the aims of this research is to determine the effect of the studied biases on shareholder value. Since my model assumes that the interests of the manager and the shareholders are perfectly aligned, the cost of managerial effort is assumed to affect shareholder value rather than just reducing the manager's own pay-off. In a practical context, this may mean either that there are opportunity costs of managerial effort being deployed to one investment rather than to another one, or that the manager's compensation is directly linked to his effort. In any case, given this assumption, any deviation from the optimal level of effort, which is obtained by setting neutral values for the parameters representing the psychological biases [$a, b = 0$; $r = 0$], represents inefficient behaviour. As a result, an associated prediction of my model is that overconfidence may lead to under- or over-provision, and regret aversion to over-provision of managerial effort, which are all inefficient equilibria.

3.3.3 Project selection

The analysis now moves back to the project selection decision. Given the effort level choices, it is now possible to consider the implications of overconfidence and regret aversion for investment selection. Deciding whether to invest in a given project or to reject the proposal was defined to be the first managerial decision problem. The diagram in figure 3.5 shows once more the decision tree for the capital investment process to illustrate the context of this decision.

Figure 3.5: Project selection decision tree



The project selection decision consists of accepting or rejecting an investment and should be made based on an investment's net present value: Any investment with a negative expected value should be rejected (general project selection rule). In the model, the subjectively expected value of the investment depends on whether the investment would be continued or abandoned in the case of bad news at the evaluation stage, and on the level of effort provided. As in the preceding analysis of the effort decision, a distinction is made again here between the case of eventual project continuation and eventual abandonment of the investment.

In order to make the analysis tractable, I shall consider here only the case when regret aversion and overconfidence regarding the state of nature offset at the evaluation stage, so that the manager makes the efficient evaluation decision (continue or abandon). Consequently, this detailed analysis considers neither any indirect effect of optimistic overconfidence nor that of regret aversion, but focuses solely on the effect of overconfidence in ability. The complete solution of the model, including the indirect effects of regret aversion and optimistic overconfidence at the project evaluation stage, however, is provided in the form of tables in Section 3.4 of this chapter.

The case of eventual project continuation

This section relates to the case when the investment would be continued subsequent to discovering underperformance in period 3. By substituting the optimal level of effort for the case of eventual project continuation (Eq-3.18) into the value function of (Eq-3.17), the subjectively expected maximum value of the investment is given by

$$(Eq-3.22) \quad \hat{V}_{ct}^* = \frac{\gamma^{2(1-a)}}{4\beta} \cdot (G - CV)^2 + CV.$$

Optimal project selection builds on the notion of an unbiased value estimate $[\hat{V}_{ct,u}^*]$ which can be derived from (Eq-3.21) by assuming zero overconfidence $[a = 0]$. Hence, the decision rule for value-maximizing investment selection for the case of eventual project continuation is

$$(Cond-3.2) \quad 0 > \hat{V}_{ct,u}^*.$$

As mentioned, regret aversion is not considered to influence the selection decision in this case. As for overconfidence, from (Eq-3.21) it can be shown that $\frac{\partial \hat{V}_{ct}^*}{\partial a} > 0$ so that the overconfident manager will overestimate the value of the investment. Intuitively, this is simply the result of the subjectively perceived higher equilibrium level of effort, induced by a biased perception of the positive effect of effort.

The case of eventual project abandonment

In this case, if the investment were found to be underperforming, it would not be worth continuing. The value of the investment given optimal effort, and expressed in terms of the optimal level of effort from (Eq-3.18) can thus be stated as

$$(Eq-3.23) \quad \hat{V}_{ab}^* = \frac{\gamma^{2(1-a)}}{4\beta} \cdot (G - L)^2 + L.$$

For an unbiased decision maker, the parameters for the psychological biases are assigned neutral values $[a = 0]$, which yields the unbiased expected value of the investment in the case of eventual project abandonment

$$(Eq-3.24) \quad \hat{V}_{ab,u}^* = \frac{\gamma^2 (G - L)^2}{4\beta} + L.$$

Since fully rational behaviour is optimal, given eventual project termination following a negative signal, any investment should be rejected for which

$$(Cond-3.3) \quad 0 > \hat{V}_{ab,u}^*$$

Since $\frac{\partial \hat{V}_{ab}^*}{\partial a} > 0$, the overconfident manager will overestimate the value of the investment such that $\hat{V}_{ab}^*(a > 0) > \hat{V}_{ab,u}^*$.

Based on the results established in this section, it is possible to state as a final proposition:

Proposition 3: *The effect of overconfidence and regret aversion on the manager's project selection decision, given that overconfidence in the state of nature and regret aversion at the evaluation stage offset.*

(a) *If the conditions for project continuation as outlined in Proposition 1 are given such that the manager **continues** the investment following a bad signal, he overestimates the value of the investment for project selection since $\hat{V}_{ct}^*(a > 0, r) > \hat{V}_{ct,u}^*$. Therefore,*

- i) If $\hat{V}_{ct}^* > \hat{V}_{ct,u}^* > 0$, the manager makes the efficient decision to accept the investment.*
- ii) If $0 > \hat{V}_{ct}^* > \hat{V}_{ct,u}^*$, the manager makes the efficient decision to reject the investment.*
- iii) If $\hat{V}_{ct}^* > 0 > \hat{V}_{ct,u}^*$, the manager makes the **inefficient decision to accept** the investment.*

(b) *If the conditions for project continuation as outlined in Proposition 1 do not hold, so that the manager **abandons** the investment following a bad signal, he overestimates the value of the investment for project selection since $\hat{V}_{ab}^*(a > 0) > \hat{V}_{ab,u}^*$. Therefore,*

- i) If $\hat{V}_{ab,u}^* > \hat{V}_{ab}^* > 0$, the manager makes the efficient decision to accept the investment.*

- ii) If $0 > \hat{V}_{ab,u}^* > \hat{V}_{ab}^*$, the manager makes the efficient decision to reject the investment.
- iii) If $\hat{V}_{ab,u}^* > 0 > \hat{V}_{ab}^*$, the manager makes the **inefficient decision to accept** the investment.

Again, these propositions also make intuitive sense: Assuming that the project selection decision is only affected by the biased effort decision, given that overconfidence and regret aversion offset at the evaluation stage, the NPV of the investment will, under certain conditions (see above), tend to be overestimated by the manager. In those cases where this bias is strong enough to make a project with a negative investment (which should be rejected) appear as having a positive NPV, the biased manager will potentially accept a bad project (inefficient decision).

In summary, the preceding analysis of the effects of overconfidence and regret aversion on the three decision steps of my capital investment decision model conducted in this section has demonstrated the following:

- (i) Optimistic overconfidence results in an overestimation of the continuation value, and may thus lead to inefficient continuation (late abandonment) of an investment, while regret aversion results in an underestimation of the continuation value and may thus lead to inefficient (premature) abandonment;
- (ii) Overconfidence in ability and regret aversion (relevant only in the continuation case) each induce higher effort but this effect is countered by the effect of optimism in the state of nature on the expected continuation value;
- (iii) Assuming that optimistic overconfidence and regret aversion in project evaluation offset (cancel out), so that the net effect on the subjectively perceived continuation value is zero, only the effect of overconfidence in ability will affect the project selection decision and potentially lead to over-investment.

These findings are summarized in the table below (Table 3.1).

Table 3.1: Summary model predictions

<i>Potential Impact on \ of</i>	<i>Overconfidence</i>	<i>Regret aversion</i>
<i>Project selection</i>	overinvestment	n.a. (see further analysis)
<i>Managerial effort</i>	greater (overconfidence in ability) or lower (optimism)	greater
<i>Project evaluation</i>	late abandonment	early abandonment

However, as the analysis (tabular form only) in the next section demonstrates, the complete solution of the model also allows for different predictions.

3.4. Complete solution of the model

Analysing the complete solution of the model is complex, since there are effectively three different biases (optimistic overconfidence, overconfidence in ability and regret aversion), as well as three decision problems. Although the analysis of the model presented so far demonstrates the most interesting effects of overconfidence and regret aversion for managerial capital investment decisions, it makes a number of simplifying assumptions in order to remain tractable. In this section, I provide the complete solution of the model for the different combinations of the biases and the resulting decision behaviour. A fundamental assumption made in the preceding analysis was that the effects of overconfidence and regret aversion exactly offset in the evaluation decision (abandonment vs. continuation), so that the analysis of the project selection decision related to the case that the continuation value was effectively unbiased [$CV = CV_u$]. Obviously, other cases are also possible, depending on which of the two effects dominates.

In the following, I provide an overview of the different possible constellations and the effect on behaviour at each of the three decision stages. I first present the solutions for each bias alone for all three decision problems before turning to analysing them jointly. Once again, I distinguish between overconfidence in ability and optimistic overconfidence, although it should be noted that in practice such a clear distinction is not possible as optimism is a symptom of overconfidence. It is found often that the solution shows that the behavioural effects of the biases depend on specific properties about a given investment and that they are thus a priori indeterminate.

3.4.1 Optimistic overconfidence alone

If the parameters for overconfidence in ability and for regret aversion are assigned neutral values [$a = 0; r = 0$], the only psychological factor to potentially affect decisions at all three stages of the capital investment decision process is overconfidence regarding the state of nature under project continuation (optimistic overconfidence). It was previously shown that this biased perception of the success probability will lead to an overestimation of the continuation value, and thus potentially to inefficiently late project abandonment. Considering the effect of an optimistically biased continuation value at the effort level stage (without overconfidence in ability), it can be shown that $\frac{\partial e}{\partial b} < 0$, hence that increasing optimism leads to decreasing effort. For a given level of optimistic overconfidence, the subjectively perceived equilibrium level of effort will be inefficiently low. Intuitively, someone who thinks that a good outcome will occur anyway is clearly not going to exert a lot of effort since this would seem unnecessary to him.

However, because effort does have an impact on the success probability in this model, under-provision of it negatively affects the objectively expected value of the project. Thus whilst optimism alone at the evaluation stage tends to favour over-investment, lower effort due to optimistic overconfidence at the effort level decision tends to counteract this effect. The overall prediction for project selection (over- or under-investment) can thus only be made in the form of a condition (see Table 3.2 below).

Table 3.2: Effect of optimistic overconfidence alone, no regret aversion

<u><i>Project evaluation</i></u>	<u><i>Effort level</i></u>	<u><i>Project selection</i></u>
$L > CV_{opt} > CV_u$ <i>Efficient abandonment</i>	<i>Efficient effort since</i> $e_{ab,opt}^* = \frac{\gamma(G-L)}{2\beta} = e_{ab,u}^*$	<i>Efficient selection since</i> $\hat{V}_{ab,opt}^* = \frac{\gamma^2(G-L)^2}{4\beta} + L = \hat{V}_{ab,u}^*$
$CV_{opt} > CV_u > L$ <i>Efficient continuation</i>	<i>Lower effort since</i> $e_{ct,opt}^* = \frac{\gamma(G-CV_{opt})}{2\beta} < e_{ct,u}^*$	<i>Overestimates value if</i> $\gamma^2 < \frac{4\beta}{(2G - CV_u - CV_{opt})}$
$CV_{opt} > L > CV_u$ <i>Inefficient continuation</i>	<i>Lower effort since</i> $e_{ct,opt}^* = \frac{\gamma(G-CV_{opt})}{2\beta} < e_{ab,u}^*$	<i>Overestimates value if</i> $\gamma^2 < \frac{4\beta}{(2G - CV_{opt} - L)}$

In the case of eventual project continuation at the evaluation stage, the effect of optimism on the project selection decision thus cannot be stated in general terms. Optimism may in this case lead to an over- but also to an underestimation of the value of the investment, and thus potentially to inefficient over- or underinvestment, respectively. However, given that overconfidence and optimism are two sides of the same coin, it is also important to understand the effect of overconfidence in ability.

3.4.2 Overconfidence in ability alone

This analysis assumes that the manager only has a biased perception of the impact of his effort, but since the state of nature in the project evaluation decision for continuation does not depend on effort, his estimate of $[q]$ is unbiased $[b = 0]$. In addition, let $[r = 0]$ so that the manager is not bothered by anticipated regret. As a result, the decision to abandon or continue a given investment is not biased but optimal, since the evaluation decision in my model is only affected by either optimism or regret aversion.. In contrast, the effort decision is affected by the overestimation of the positive impact the manager can make through his effort contribution, and this feeds through to an overestimation of the value of the investment, potentially thus leading to overinvestment when $\hat{V}_{oc}^* > 0 > \hat{V}_u^*$. These effects are formally shown in Table 3.3 below.

Table 3.3: Effect of overconfidence regarding ability alone, no regret aversion

<u>Project evaluation</u>	<u>Effort level</u>	<u>Project selection</u>
$L > CV_{oc} = CV_u$ <i>Efficient abandonment</i>	<i>Higher effort since</i> $e_{ab,oc}^* = \frac{\gamma^{(1-a)}(G-L)}{2\beta} > e_{ab,u}^*$	<i>Overestimates value since</i> $\hat{V}_{ab,oc}^* = \frac{\gamma^{2(1-a)}(G-L)^2}{4\beta} + L > \hat{V}_{ab,u}^*$
$CV_{oc} = CV_u > L$ <i>Efficient continuation</i>	<i>Higher effort since</i> $e_{ab,oc}^* = \frac{\gamma^{(1-a)}(G-CV_u)}{2\beta} > e_{ab,u}^*$	<i>Overestimates value since</i> $\hat{V}_{ct,oc}^* = \frac{\gamma^{2(1-a)}(G-CV)^2}{4\beta} + CV > \hat{V}_{ab,u}^*$

The effect of overconfidence in ability here is again rather straightforward: Since the expected value of the investment is a function of managerial effort, greater effort will induce an overestimation of the project's NPV. Whenever the subjectively expected NPV is biased such that the 'true' negative NPV of an investment appears to be positive, overconfidence in ability will lead to an inefficient selection decision.

3.4.3 Regret aversion alone

I now consider the case where the manager is only regret averse [$r > 0$] but is otherwise unbiased, and in particular, is in no way overconfident [$a, b = 0$]. The solutions of my model for this case can be seen in Table 3.4. At the project evaluation stage, regret aversion alone leads to an underestimation of the continuation value and thus tends to favour inefficient premature abandonment; this is because the manager is assumed to be concerned about the regret he would feel for continuation³⁷ if the bad state of nature occurred.

Concerning the manager's effort level, it is interesting to note that the model predicts regret aversion to result in higher effort for the case of continuation or inefficient abandonment at the project evaluation stage. Hence, if the investment and the manager's expectations are such that the project will be continued following a bad signal, the regret-averse manager will tend to work harder; and similarly for the case of inefficient abandonment.

Table 3.4: Effect of regret aversion alone, no overconfidence

<u><i>Project evaluation</i></u>	<u><i>Effort level</i></u>	<u><i>Project selection</i></u>
$L > CV_u > CV_{ra}$ <i>Efficient abandonment</i>	<i>Efficient effort since</i> $e_{ab,ra}^* = \frac{\gamma(G-L)}{2\beta} = e_{ab,u}^*$	<i>Efficient selection since</i> $\hat{V}_{ab,ra}^* = \frac{\gamma^2(G-L)^2}{4\beta} + L = \hat{V}_{ab,u}^*$
$CV_u > CV_{ra} > L$ <i>Efficient continuation</i>	<i>Higher effort since</i> $e_{ct,ra}^* = \frac{\gamma(G-CV_{ra})}{2\beta} > e_{ct,u}^*$	<i>Overestimates value if</i> $\gamma^2 < \frac{4\beta}{(2G-CV_u-CV_{ra})}$
$CV_u > L > CV_{ra}$ <i>Inefficient abandonment</i>	<i>Higher effort since</i> $e_{ab,ra}^* = \frac{\gamma(G-L)}{2\beta} > e_{ct,u}^*$	<i>Overestimates value if</i> $\gamma^2 < \frac{4\beta}{(2G-CV_u+L)}$

This prediction is a result of the more conservative evaluation of the project due to regret aversion, which in turn leads to the perception that 'more is at stake' [$(G - CV_{ra}) > (G - CV_u)$; $(G - L) > (G - CV_u)$], meriting greater effort. As a result of this higher effort, and depending on the specific relative costs and benefits of effort, the regret-averse manager overestimates the value of the investment unless it is to be

³⁷ Note that this is due to the model's specific assumption on (partial) outcome observability.

abandoned eventually anyway. Hence, regret aversion alone may lead to inefficient over- but also underinvestment.

To summarize the findings on the effects of each bias in isolation, it can be noted that:

- (i) Overconfidence regarding the state of nature may lead to inefficient continuation, lower effort and inefficient project selection decisions;
- (ii) Overconfidence regarding ability will not affect the continuation / abandonment decision (in this model set-up), but may lead to higher effort and inefficient over-investment;
- (iii) Regret aversion may lead to inefficient premature abandonment (under the assumption of partial outcome observability), higher effort and inefficient project selection decisions.

When considered in isolation, and assuming the cost of effort to affect shareholder value, optimistic overconfidence, overconfidence regarding ability and regret aversion thus only³⁸ have potentially negative (in a shareholder value sense) consequences on managerial capital investment decisions. However, when the (realistically likely) case is considered that all of the studied psychological phenomena may simultaneously affect the manager's decisions, the effect of one individual bias is no longer necessarily only bad, but may be positive by offsetting the other bias. This is demonstrated in the following sub-section.

3.4.4 Overconfidence and regret aversion combined

This analysis now considers the case that the manager is both overconfident (regarding his ability as well as the state of nature) and regret averse. By way of structuring the analysis, I distinguish between two cases based on which, overconfidence or regret aversion, dominates³⁹ at the evaluation stage. Given the different interactions, the

³⁸ If overconfidence is not split into optimism and overconfidence in ability, the optimal level of effort may be obtainable in the case of eventual continuation if $\gamma^a = \frac{(G - CV_{oc})}{(G - CV)}$.

³⁹ The case when these two biases offset was already considered in Section 3.3.

analysis of the general case is rather complex and in most cases can only describe the conditions for certain behaviour.

Table 3.5: Combination of overconfidence and regret aversion

<u>Project evaluation</u>	<u>Effort level</u>	<u>Project selection</u>
a) $OPT > RA$		
$L > CV_b > CV_u$ <i>Efficient abandonment</i>	<i>Higher effort since</i> $e_{ab,b}^* = \frac{\gamma^{(1-a)}(G-L)}{2\beta} > e_{ab,u}^*$	<i>Overestimates value since</i> $\hat{V}_{ab,b}^* = \frac{\gamma^{2(1-a)}(G-L)^2}{4\beta} + L > \hat{V}_{ab,u}^*$
$CV_b > CV_u > L$ <i>Efficient continuation</i>	<i>Higher effort if</i> $\gamma^a < \frac{(G-CV_b)}{(G-CV_u)}$	<i>Efficient selection if</i> $\hat{V}_{ct,b}^* = \hat{V}_{ct,u}^*$
$CV_b > L > CV_u$ <i>Inefficient continuation</i>	<i>Higher effort if</i> $\gamma^a < \frac{(G-CV_b)}{(G-L)}$	<i>Efficient selection if</i> $\hat{V}_{ct,b}^* = \hat{V}_{ab,u}^*$
b) $OPT < RA$		
$L > CV_u > CV_b$ <i>Efficient abandonment</i>	<i>Higher effort since</i> $e_{ab,b}^* = \frac{\gamma^{(1-a)}(G-L)}{2\beta} > e_{ab,u}^*$	<i>Overestimates value since</i> $\hat{V}_{ab,b}^* = \frac{\gamma^{2(1-a)}(G-L)^2}{4\beta} + L > \hat{V}_{ab,u}^*$
$CV_u > CV_b > L$ <i>Efficient continuation</i>	<i>Higher effort if</i> $\gamma^a < \frac{(G-CV_b)}{(G-CV_u)}$	<i>Efficient selection if</i> $\hat{V}_{ct,b}^* = \hat{V}_{ct,u}^*$
$CV_u > L > CV_b$ <i>Inefficient abandonment</i>	<i>Higher effort since</i> $e_{ab,b}^* = \frac{\gamma^{(1-a)}(G-L)}{2\beta} > e_{ct,u}^*$	<i>Efficient selection if</i> $\hat{V}_{ab,b}^* = \hat{V}_{ct,u}^*$

Given below are the conditions under which project selection behaviour may be efficient despite the influence of overconfidence and regret aversion. If these conditions are not given, then the result will be either inefficient over- or underinvestment.

a) $OPT > RA$: Indeterminate cases

$$(i) \quad \hat{V}_{ct,b}^* = \hat{V}_{ct,u}^* \rightarrow \frac{\gamma^{2(1-a)}(G-CV_b)^2}{4\beta} + CV_b = \frac{\gamma^2(G-CV_u)^2}{4\beta} + CV_u$$

$$(ii) \quad \hat{V}_{ct,b}^* = \hat{V}_{ab,u}^* \rightarrow \frac{\gamma^{2(1-a)}(G-CV_b)^2}{4\beta} + CV_b = \frac{\gamma^2(G-L)^2}{4\beta} + L$$

b) $OPT < RA$: Indeterminate cases

$$(i) \quad \hat{V}_{ct,b}^* = \hat{V}_{ct,u}^* \rightarrow \frac{\gamma^{2(1-a)}(G - CV_b)^2}{4\beta} + CV_b = \frac{\gamma^2(G - CV_u)^2}{4\beta} + CV_u$$

$$(ii) \quad \hat{V}_{ab,b}^* = \hat{V}_{ct,u}^* \rightarrow \frac{\gamma^{2(1-a)}(G - L)^2}{4\beta} + L = \frac{\gamma^2(G - CV_u)^2}{4\beta} + CV_u$$

Concerning project selection, for which it was assumed in the preceding section that the effects of regret aversion and optimistic overconfidence exactly offset, it can be noted that removing this restriction any type of behaviour is theoretically possible.

3.5 Summary

In this chapter, I presented a model that includes the project selection, managerial effort and project evaluation decision problems as defined for this research. I assumed a value-maximizing decision maker whose interests are perfectly aligned with those of shareholders. I also presented ways in which the two studied biases of overconfidence and regret aversion could be represented formally and consistent with the insights on these phenomena gained from the literature review. The model was then solved by backward induction under certain limiting assumptions. Overall, the results of this analysis suggest that each bias individually, unless it is not sufficiently strong to have any noticeable impact, will lead decision behaviour to deviate from the normatively optimal and efficient solution.

In addition, however, I also demonstrated that a combination of the studied biases can have opposite effects, thereby potentially leading to the efficient⁴⁰ decision behaviour if they offset. Alternatively, their individual effects will be reinforcing, in which case behaviour will be inefficient. Given the complexity of the interaction of the two biases, however, the empirical research to be introduced in the following chapter shall focus exclusively on investigating the proposed individual effects of overconfidence or regret aversion resulting from the presented analysis of the three capital investment decision problems, leaving an empirical exploration of the interaction effects of these biases to future research.

⁴⁰ This is also a result of the model by Besharov (2002), and will be of interest in the discussion of the costs and benefits of psychological biases in managerial capital investment decisions in Chapter 6.

CHAPTER 4: DATA COLLECTION METHODS

In the preceding chapter, I presented my model of the capital investment decision process and derived predictions on the potential effects of managerial overconfidence and regret aversion. However, 'all theory is grey'⁴¹. In this chapter, I thus present my approach to collecting data in order to enrich my theoretical propositions with some empirical evidence. I start by briefly highlighting some of the implications of the general paradigm⁴² of my research on the research methodology. In the second section, I offer a review of the methods used in existing, related research efforts reported in the literature. Based on the insights and inspirations gained from this review, I define the way in which data will be collected in the present research, and outline strengths and weaknesses of the chosen approach. Finally, the remainder of the chapter is dedicated to a detailed presentation of the design of my survey questionnaire and the two experiments. The wider purpose of this chapter in the presentation of my research is thus to provide an account of the data collection process and its underlying considerations for the purpose of facilitating an assessment of the quality of my data.

4.1 Epistemological considerations

Developing hypotheses first and then investigating whether they match with reality reveals a deductive and positivist⁴³ view of how knowledge is created (Johnson & Duberley, 2000:41), and is typical of research in Finance and Economics. Such a general epistemological perspective has several implications for the design of the data collection process. Of central importance is the way in which the empirical data should be interpreted with relation to the theoretical propositions. For this, the principle for testing hypotheses proposed by Karl Popper (1963) is to be considered. According to Popper, in order to be testable, a hypothesis must be stated in a way that clearly disallows a certain event; genuine data collection should then be directed at discovering just a single instance of the event ruled out by the theory. Even if this is

⁴¹ Goethe, Faust I, Mephisto 2038f.

⁴² Kuhn (1962:11) defines the term paradigm as a set of „rules and standards for scientific practice“.

⁴³ While it is not argued that this thesis reflects a purely positivist approach, the work is certainly oriented towards this paradigm and has sought to adhere to its core requirements.

not achieved despite credible efforts, the theory is still not proven but only strengthened. For the proposed causal effects of overconfidence and regret aversion on capital investment decisions, Popper's falsification principle implies that my methodology must be suited to collecting data by which an association between the two variables can be tested.

However, positivism's proposition that theory can be tested and potentially be refuted by empirical findings implies that reality is objectively observable⁴⁴. Hence, the fact that I managed to observe something must mean that anyone else can observe the exact same thing under the same circumstances. In order to ensure that observations are truly objective, so that general conclusions can be drawn from them, the findings must be reliable and valid. Reliability implies that any other researcher could replicate the findings when following the same methodology; as a result, the methodology should adhere to a clear structure (Gill & Johnson, 1997:8) such that the impact of any bias introduced by the researcher is minimized and the findings are as objective as possible (Saunders, Lewis, & Thornhill, 2000:85). Regarding the validity of findings, two types of validity are distinguished. External validity refers to the extent with which findings can be generalized beyond the analysed data set; in contrast, internal validity is concerned with the strength and accuracy of identified cause-effect relationships (Malhotra & Birks, 2003:762).

Yet, while reliability and validity of the data are defined targets of positivist research, in reality they can only be aspired to but are hardly ever achieved. Given different strengths and weaknesses of the commonly used methods, a trade-off is to be made. One method may be very good in terms of reliability, but not optimal as far as internal validity is concerned. External validity has traditionally been most highly valued by researchers in Finance. As a consequence, statistical significance testing of the findings dominates data analysis. Since statistical results become more robust as they approximate the population, sampling methods where large numbers of observation points can be collected are often used.

Still, even a statistically significant correlation does not necessarily imply a cause-effect relationship, as the variables may also just happen to correlate for some external reason (spurious relationship). Furthermore, hypothesis testing implies that all

⁴⁴ This is a view not shared by all researchers. The constructivist school of thought argues that reality is subjectively construed and perceived, and may thus vary from one individual to another.

variables are directly observable and measurable, but in reality, this is often not the case and ‘proxies’ have to be found⁴⁵. Finally, another inevitable problem, known as the Duhem-Quine thesis⁴⁶, resides in the fact that no hypothesis can ever be tested in isolation. Even in a highly controlled environment experiment, there are several connected hypothesis that are tested jointly.

In the light of these considerations, and the restrictions on the choice of methodology arising from the research paradigm in particular, I returned to the literature in order to find out what methods had been used in earlier but related research. The next section provides a review of the articles on which the data collection methods of the present research lean upon, and to which they can be compared.

4.2 Data collection methods used in the related literature

Since my research introduces elements from Psychology to classical Finance decision problems, relevant contributions reviewed in this section are drawn from both bodies of literature. The section thus contains two parts: In the first part, reported empirical research related to investment project selection, managerial effort and the evaluation decision (continuation or abandonment) is presented. In the second part, techniques for collecting information on the studied psychological phenomena of overconfidence and regret aversion employed by other researchers are discussed.

4.1.1 Observing capital investment decisions

Project selection

Much of the research on the practice of investment selection has been conducted in the form of surveys. Recent examples include Arnold & Hatzopoulos (2000), Graham & Harvey (2001) and Akalu (2002). Primarily, these surveys have centred on the use of appraisal techniques in order to establish the extent to which practitioners follow the recommendations of corporate finance theory. As a result, the questionnaires employed in that research are mostly limited to closed multiple-choice questions where managers

⁴⁵ Clearly, in the specific context of this research, the study of psychological factors such as overconfidence and the aversion to regret is most acutely affected by this problem.

⁴⁶ The Duhem-Quine thesis is mentioned for instance by Cross (1982); an in-depth discussion of this thesis and its relevance for experimental research in economics is offered by Soberg (2005).

can indicate which specific financial techniques they use. Yet as important as knowing *how* managers appraise investments may be, the existing research often leaves unanswered the question of *why* such decisions are made the way they are. To some extent an exception to this criticism are Graham et al. (2001) who compare differences in responses across sub-samples of the respondent set (p.118).

A second research method that appears to have been popular is the direct observation of individuals' investment decisions in experiments. However, most experiments seem to have studied investments in a financial markets context (e.g. Moore, Kurtzberg et al., 1999; El-Sehity, Haumer et al., 2002) so that their designs are not easily transferable to the topic of selecting a capital investment. An exception represents the experiment reported by Dittrich, Gueth, & Maciejovsky (2001) which offers features relevant to the design of my methodology. In this experiment, subjects receive a certain budget and can choose how much of this they want to invest in a single risky asset; any funds not spent are invested by default in a risk-free asset (Dittrich et al., 2001:8). Another feature of this experiment is the measurement of individual risk preferences, which allows the authors to distinguishing between rational and overconfident choices (p.15) in their investigation of the relevance of this bias for the studied decision task. The experiment is conducted using computers and a special software guiding subjects through the task and recording their decisions, which represents an impediment to direct adaptation to this research, though.

Finally, a case study method was employed by Bromiley (1986). Although this method theoretically benefits from direct and detailed observations of the investment selection decisions of practitioners, as opposed to experimental subjects, having only a low number of observations seriously limits generalisation of the findings. Under a positivist research paradigm, case studies are thus typically not considered to deliver meaningful insights.

Effort

Several studies that measure individual effort were found. Technologically the most sophisticated, Stone's (1994) experiment is fully computer based. Effort in this experiment is measured as the time individuals spend on a decision task, recorded by the computer. Yet while this approach to measuring effort is rather straightforward, it may also be argued that higher concentration or better ability of individual subjects may lead to shorter completion times without necessarily representing lower effort. In

addition, development of such software is beyond the scope of the present research. Rather than observing individual effort indirectly, other researchers have taken a more direct approach by asking participants about their level of effort in a given situation. Whilst Gueth, Klose et al. (1998) do so within an experimental framework, Cooper et al. (1995) conducted a survey to investigate individual levels of effort in an investment setting.

In the experiment by Gueth et al. (1998), the group of subjects is divided up into principals and agents. A principal offers a payment contract, which contains fixed and variable (based on firm value) elements, to an agent. The agent then chooses his effort out of four different permissible levels, where effort comes at a cost reducing an agent's payoff. Firm value at the end of the period – relevant for the variable part of an agent's income – depends on the agent's effort and a chance variable. Participants indicate their level of effort on a response form. The experiment is designed in such a way that only either zero or full effort should be observable (Gueth et al., 1998:334) based on the game-theoretic solution. The general principle of observing effort here seems very useful: Subjects make a conscious decision on their effort level and are aware of the costs and benefits associated with exerting effort. Under this quite realistic set-up, behaviour can be argued to be approximating the model assumption of a value-maximizing trade-off under uncertainty. One small shortcoming of this experiment is the neglect of individual risk preferences, which the authors argue, though, was intentional so as to limit the complexity of the game (p.332).

In contrast, the large-scale survey by Cooper et al. (1995), with 13,000 posted questionnaires, targeted entrepreneurs who had recently started a new business. Cooper and his colleagues were interested in the degree to which these entrepreneurs had engaged in information search prior to launching their venture. As part of their questionnaire, they asked participants to evaluate several sources of information – such as relatives, consultants or books – based on how important they had been in their information gathering preceding the start of the business. The researchers then compute a measure for the number of sources used, and their relative importance for each individual entrepreneur (Cooper et al., 1995:111). This measure thus pertains to the degree of preparation undergone by an entrepreneur and can hence be interpreted as a proxy for individual effort. However, since reported effort levels may be inaccurate given the responses are made in retrospective, it would seem that eliciting

effort level decisions directly as in the experiment by Gueth et al. (1998) may be a better way of collecting the required data.

Project evaluation

The issue of how managers deal with ongoing investments, in particular when a project is losing money has been investigated mainly experimentally. The only research I am aware of that uses secondary data (companies' stock price movements following project abandonment announcements) is by Statman et al. (1989). The experimental method thus seems to dominate investigations of the decision problem of abandoning or continuing a failing investment.

A relatively recent study using an experiment is reported by Chang & Ho (2004); interestingly, their methodology is somewhat hybrid by combining elements of a survey with their experiment. Chang et al. (2004) set out to compare the project evaluation decisions of managers with those of students, and post an 'experimental package' to the managers. Since the managers complete the questionnaire at home, this method is arguably more of a survey, lacking the controlled conditions of a proper experiment.

On the other side, it is difficult to get managers to participate in research at all, let alone to participate in a formal experimental session. All participants evaluate one project only, and receive information on the project's projected cash flows, previous investments made, the degree of completion and the amount required to continue the investment. Subjects then learn that either one of two states of nature has occurred, representing a favourable or an unfavourable market development (Chang et al., 2004:104). They are instructed that a further cash injection into the project would be required and are asked to decide whether to do this and continue or whether to abandon the investment.

In another experiment, conducted by Harrison & Harrell (1993), the subjects (MBA students) are provided with financial background information on four investment projects. Uncertainty is introduced as in Chang et al. (2004) through two possible states of nature. Based on the data available to subjects, an optimal strategy exists: Two investments have a projected internal rate of return for the remainder of their lifetime greater than the defined 'hurdle rate', whilst the other two investments have negative IRRs (Harrison et al., 1993:639). The former should thus be continued and the latter terminated. Project abandonment results in a positive cash flow that is

reinvested in a risk-free asset at a fixed rate of return, greater than the hurdle rate. Subjects' decisions on each of the four investments are recorded by Harrison et al. (1993) on a ten-point scale, allowing participants to indicate not only their choices but also how much confidence they have in these.

Subjects in the project evaluation experiment by Kogut & Phillips (1994) repeatedly decide whether to continue or abandon an investment using computer software that creates a series of virtual evaluation decision problems. This programme follows down a pre-defined decision tree randomly for up to five periods, or until abandonment. In each period, with a certain probability, the expected value of the investment can go either up or down (Kogut et al., 1994:464). Given this new value estimate, subjects can continue by making an additional investment at the end of each period, or otherwise stop. Following the optimal stopping rule, the investment should be abandoned once marginal cost (the investment required to continue) exceeds the expected value of the investment. Once again, however, a direct adaptation of this dynamic method is prevented by the considerable complexity of developing such software.

4.1.2 Observing psychological biases of individuals

The second challenge for the present research is the integration of psychological factors into the methodology. The question of how individual overconfidence and regret aversion can be observed is crucial to this research. In addition, the data should be such that inferences about the predicted causalities of the studied biases on capital investment decisions can be made. To provide some guidance on addressing these questions, several contributions from the literature proved to be useful, and are reviewed in this section.

How to study individual overconfidence empirically

In the presentation of the overconfidence bias based on literature in Psychology, different 'symptoms' of overconfidence were outlined. It is thus plausible to measure individual overconfidence by measuring these individual symptoms. An excellent paper that does this, and which provides the foundation for the way overconfidence is measured throughout my data collection, is presented by Glaser et al. (2003).

One definition of overconfidence relates to an unjustified, excessive belief in the accuracy of one's beliefs. In other words, it is an underestimation of the errors one is making. Following this interpretation, overconfidence is most directly captured by

assessing an individual's calibration. Someone is said to be well calibrated when his meta-knowledge (how much he knows he actually knows) is about accurate, and mis-calibrated otherwise. Calibration can be measured in two ways. Aukutsioneck & Belianin (2001) define calibration as "the empirical frequency of forecasts that have been correct, related to the judged probability that these forecasts will be true" (p.662). Consequently, they measure it by presenting subjects with a list of binary choice questions and asking them afterwards how many they think they answered correctly. Overestimation of the number of correct answers is taken as evidence of overconfidence. An alternative approach is to use confidence intervals. Here, subjects state confidence intervals for some unknown value they are asked to estimate. Since narrow intervals should represent greater confidence in the estimate, the percentage of confidence intervals that are given as too narrow can be used as a measure of overconfidence (e.g. Glaser et al., 2003: 18ff).

Another technique to identify overconfidence is to check for extreme or unjustified levels of optimism in participants' beliefs about future events; this link between overconfidence and optimism was outlined previously (Weinstein, 1980). Glaser et al. (2003:22) build on this finding and ask stock market investors to estimate the future return on their portfolios, and set this in relation to participants' responses regarding past portfolio returns to calculate a measure of optimism. Similarly, Moore et al. (1999:98) conjecture that an overestimation of one's portfolio returns is a signal for optimism. As part of their experiment, subjects also responded to a question on how they believed their investment would perform (p.103).

In addition, Glaser et al. (2003) probe for the illusion of control, which was also shown to be related to overly positive expectations (Langer, 1975), by asking for the extent to which a stock market investor believes he is in control of the performance of his portfolio (p.22, Q3), and include the response in their optimism measure. A further measure of overconfidence proposed by Glaser et al. (2003) is based on the better-than-average effect of overconfidence. Overconfident people overestimate their own ability and skill both in absolute and relative terms. Glaser et al. (2003) explore the participating investors' illusion of control by asking them to rank themselves relative to other investors with regard to skill, and past performance (p.21).

The better-than-average concept also features in Camerer & Lovo's (1999) experiment of the effects of overconfidence on market entry, where pay-offs depend on the (actual) ranking of subjects based on their individual performance in a general

knowledge quiz (p.308). The rankings are not made available to participants, so that they remain uncertain their relative 'ability' throughout the experiment. Yet because Camerer et al. (1999) limit market size such that only the top-ranking participants will receive a positive cash flow, subjects' market entry decisions are effectively made based on beliefs about own performance (and thus ability) compared to that of others. Consequently, the decision to enter the market is indicative of individual confidence: Subjects who did poorly in the quiz but still chose to enter the market must (overconfidently) have thought themselves to be better than they were; similarly, top-performers who stayed out can reasonably be considered to lack confidence. This prediction was confirmed by the finding that in the control group, where ranks depended on chance only, subjects were less likely to enter the market (Camerer et al., 1999:314).

How to study individual regret aversion empirically

The second psychological phenomenon on which my empirical research needs to collect data is regret aversion. It is fairly intuitive that most people experience a disutility from feeling regret. Researchers studying regret aversion have therefore simply focused on post-decision regret and assumed anticipated post-decision regret would lead to, or had triggered, regret-aversion. In the literature, two broad approaches to the study of regret aversion and its behavioural effect can be distinguished. The field can be split into those who see regret-aversion as endogenous and pervasive, and those arguing that it is exogenous and can thus be induced.

In the former approach, researchers look for indications in participants' statements that regret was a factor in the decision process, and sometimes also to what extent so. In the latter approach, behaviour under a regret-treatment is compared with that of a control group. This distinction between underlying views of regret aversion entails differences in the research method. In the following, I consider contributions of both perspectives to demonstrate the ambiguity related to measuring regret aversion and the resulting methodological creativity of past research efforts.

Fisher et al. (2003) cite interview comments of practitioners to support their proposition that regret aversion is one of the chief drivers behind corporate hedging behaviour. Companies have been found to switch from unhedged to hedged portfolios even though they should be indifferent as both strategies have comparable risk and return properties. Fisher et al. (2003:8) quote a fund manager who reflects on what

might have happened if he had hedged Asian currencies as opposed to his actual decision not to hedge, and propose that such thoughts are indicative of ex-post regret. Other researchers enquire directly about any feelings of regret in a given scenario. Gilovich et al. (1995) question randomly selected US citizens by telephone on whether they regretted actions more than inactions. Feldman et al. (1999:236) criticize this method and conduct experiments in which subjects are asked to recall a regrettable decision, to describe it and to rate the intensity of the regret on a seven-point scale. However, while such a technique avoids some of the shortcomings of Gilovich et al.'s (1995) approach highlighted by Feldman et al. (1999:236), the large time lag between the actual decision and the emotional evaluation is a potential shortcoming of the Feldman et al.'s (1999) method. When post-decision regret is considered possibly several years after a decision was taken, it may be questioned if the passing of time has not in some way affected the respondent's perception of what had once motivated his decision in terms of ex-ante, anticipated regret.

That particular concern is reduced in the experiments by Connolly, Ordóñez, & Coughlan (1997). Subjects read a case about two people who find out that they shared the worse of two possible outcomes (p.76); the twist in this story though is that only one person was *en route* to this outcome from the start (with no chance to change things) whereas the other person ended up there by his own decision (condition 1) or through a random event (condition 2). Connolly et al. (1997) ask their subjects to indicate who (if any) of the two fictitious individuals would feel more regret upon learning their outcome condition, and how happy they would be at the end. The method used here by Connolly et al. (1997) thus represents a vehicle for eliciting individual propensity for regret, assuming that subjects personally identify with the story's characters. Compared to Gilovich et al. (1995), Connolly et al. (1997) study regret temporally close to the actual decision. But because subjects are not themselves faced with the decision problem, this data collection approach may be argued to lack authenticity as far as subjects' responses are concerned.

The articles discussed above all share in common that by asking individuals directly about experienced regret, they only investigate ex-post – as opposed to anticipated – decision regret. In contrast, empirical research where an anticipation of eventual regret is created prior to decision-making is able to investigate the behavioural effects of regret aversion directly. For instance, Ordóñez, Benson, & Beach (1999) report on an

experiment in which they explicitly advised subjects in the treatment group prior to their making any decision to consider the regret the latter might feel upon finding out subsequently that their decision had been sub-optimal (p.75). Interestingly, Ordonez et al. (1999) find that this treatment only has an effect when subjects are warned about the regret of having foregone a good outcome, but not when the treatment consists in drawing their attention to potential regret from having made a bad decision (p. 77). By way of contrast, the notion of regret is not mentioned to subjects at all in the experiments conducted by Ritov (1996).

Ritov's (1996) experiments are partly computer based and are made up of several pairs of gambles for which subjects indicate their preferred option (p.231). Some subjects were instructed that they would receive information on the outcomes of all gambles, while for others only the outcomes of the chosen options would be revealed (p.233). The treatment in Ritov's experiments is thus effectively the type of outcome resolution, which serves as a means of inducing regret aversion. This approach, which is consistent with my model, can also be found in the experiment by Zeelenberg et al. (1996) and Zeelenberg et al. (1997). One experiment described by them involves a choice between two types of financial assets with differing risk criteria (Zeelenberg et al., 1997:66). Subjects in the treatment group receive feedback on the chosen investment as well as on the outcome of the low-risk alternative investment, whereas control group members are briefed on the outcome of their chosen asset only (p.66). Decisions are recorded on two seven-point semantic preference scales, one for each investment product, ranging from 'definitely would not invest' to 'definitely would invest' (Zeelenberg et al., 1997:66).

4.2 Methodological considerations

As mentioned previously, developing a research methodology and selecting an appropriate data collection method should be driven by the type of data needed to address the theoretical propositions. For the present research on the effects of managerial overconfidence and regret aversion, most importantly, the claims about the existence and relevance of these two phenomena in the chosen context need to be tested. Overconfidence was shown for a range of different professionals (see literature review), so there is some hope that evidence on this bias will also be found for my target group of managers who are in charge of capital investment decisions; yet this

cannot be assumed to be given, and for the case of regret aversion, no prior study has demonstrated its existence among corporate finance decision makers. Second, data on the independent variables in the model, the managerial decision behaviour, must be obtained. Observations of project selection, individual effort and project evaluation decisions are thus to be collected alongside the psychometric data. Third, there ought to be measures that can be used to evaluate the role of external factors such as moral hazard.

The ideal method would thus need to gather individual psychological data on a large number of corporate finance managers or other managers responsible for capital investment decisions, in real-time, and guarantee the absence of any disrupting alternative drivers of the observed behaviour. In Bavaria, a country with a strong pastoral culture, people refer to such an ideal as a 'milk-producing, woolly pig that can lay eggs'⁴⁷. Just as with productive livestock, no single data collection method seems able to offer all properties desirable. The review of the related literature with regard to data collection methods has shown that experiment and survey appear to be dominant in research on individual investment decisions; with the exception of the survey by Glaser et al. (2003), overconfidence and regret aversion have so far largely been investigated experimentally. In the following, I therefore examine these observations more closely.

4.2.1 Methodological considerations relating to surveys

A survey⁴⁸ potentially offers some advantages that would be beneficial to my investigation. Most importantly, a survey questionnaire permits a standardized recording of first-hand data by directly collecting feedback from practitioners. In research that makes propositions regarding managerial decision behaviour, such insights are obviously very valuable. It has also been suggested that surveys are ideal for the investigation of variable associations in a likely multi-causal situation (Oppenheim, 1992:21); hence, a survey could explore the potential role of several factors like overconfidence, regret aversion, and moral hazard in capital investment decisions quite efficiently. In addition, there are a number of practical advantages to

⁴⁷ The infamous "Eierlegende Wollmilchsau".

⁴⁸ Although a survey can also consist of a series of interviews, the term is used here to describe questionnaire mailings only.

conducting a survey that are relevant to the present research. Administering a questionnaire is possible with limited resources, and represents an efficient way of gaining access to top-level corporate decision makers who are normally very busy, because respondents can complete the survey questionnaire by themselves and at a time that suits them best. Theoretically, this should increase the willingness of practitioners to contribute to academic work.

However, surveys are also criticized for being only able to record beliefs at best, and ‘socially desirable’ comments that do not reflect the facts at worst (Aldridge & Levine, 2001:103). Clearly, the fact that the researchers does not know if responses reflect sincere opinions, and even if they do, whether they are accurate of reality, poses a limitation to what can be inferred from survey data. However, the collection of purely quantitative firm-level financial data may also be distorted by certain accounting methods, so that it can be argued that empirical data at the corporate level will always be subject to some distortion.

Another problem with surveys is that there may be a divergence in the interpretation of questions between the researcher and the respondent, aggravated by the fact that, in case they do not understand a question, respondents will rarely turn to the researcher for clarification for reasons of time and lack of interest. It is therefore very important to formulate questions such that respondents will understand what the researcher wants to know; in other words, the ambiguity in survey questionnaires strictly must be minimized.

This requirement attaches great importance to the design of individual questions and the construction of the questionnaire as a whole. Even though Malhotra et al. (2003) note that “there are no scientific principles that guarantee an optimal or ideal questionnaire” (p.326), they offer several useful insights regarding the design of a questionnaire. On the issue of ambiguity, they caution that some questions may be perceived as leading to a certain response option and that this should be avoided (Malhotra et al, 2003:328). Moreover, since a crucial component of respondents’ willingness to participate in a survey is the time needed to respond to all questions, questionnaires should be relatively efficient to go through; hence, the questionnaire should rather be shorter than longer, and only questions that are truly needed in the research should be featured.

A further point raised by Malhotra et al. (2003) is the importance of structure in improving response rates: Questions that may seem threatening to participants (which

is arguably the case for inquiring about overconfidence or regret aversion and inefficient decision making) should be placed towards the end of the questionnaire in order to establish a certain rapport with the respondent (Malhotra et al., 2003: 328).

4.2.2 Methodological considerations relating to experiments

In experiments, a sample group of subjects is submitted to a treatment (independent variable) and the resulting effect on the dependent variable(s) is observed and measured (Hussey & Hussey, 1997:60). The purpose of experiments is thus to study the influence of one variable on one or several others in order to make inferences about possible causal relationships. Experiment as a research methodology originates from the natural sciences, where laboratory tests of cause-effect relationships between variables under controlled environmental conditions are well established. According to Malhotra et al. (2003:206), for conducting social experiments, three requirements for making inferences must be met: (i) the variables must vary together (concomitant variation), (ii) the suspected cause (treatment) must occur prior to or simultaneously with the suspected effect, (iii) and extraneous factors must be controlled for. Clearly the most significant benefit of an experimental methodology lies in the possibility of studying the effect of only one treatment in relative isolation (Johnson et al., 2000:45), which is owed to the mentioned controlled decision environment.

However, when experiments are criticised, it is particularly this aspect of control that is targeted. The typical criticism is that experiments are too artificial to be meaningful (Oppenheim, 1992:12). As a consequence, the laboratory set-up might cause the behaviour of subjects to be influenced by their role as subjects in an experiment, as opposed to the presumed more natural behaviour in the real world decision making (Rosnow & Rosenthal, 1997:8). These arguments may be valid to some extent, but they do not provide a basis for discarding experiments as a useful research method in testing cause-effect relationships in general (Dobbins, Lane, & Steiner, 1988). It is precisely the ‘artificiality’ which enables researchers to isolate specific variables of the causal relationship under investigation (e.g. Nelson, Krusche, & Bloomfield, 2003:505). In a corporate context, a manager may take a particular decision not because he is biased but because his superior has expressed a preference for a given strategy, and the manager does not wish to counteract. The risk of such spurious relationships should thus be lower for experimental data.

Another frequently mentioned demand on experiments is that they must be ethical, particularly as they involve human beings (Blaxter, Hughes, & Tight, 2001:75). In particular, subjects should not be misled or deceived in the experiment, as Cadsby et al. (1998:281) argue, because this might entail damaging repercussions for the reputation of experiments in general. On the other hand, and especially in the case of studying the role of cognitive biases, subjects should not be fully informed about the purposes of the experiment or different parts of it either, because this might cause behaviour to be 'unnatural'. Further points of consideration in the design of an experiment mentioned by Cadsby et al. (1998) include deciding which experimental materials should be made available for subjects, the type and number of treatments to be administered, the subject group, and the use of incentives for participants. Regarding whether subjects should be given incentives to introduce an incentive for them to perform well in an experimental game, Cadsby et al. (1998:277) find that “the average payment per subject ranges as high as \$165 for 2h to no payment at all” but argue, though, that rewards are essential to make participants take real economic decisions (p.286).

Finally, concerns are frequently voiced as to whether students do not make good experimental subjects because of differences compared to managers that would impede external validity (Remus, 1996; Tosi, Brownlee et al., 2003; Chang et al., 2004). However, not least because they are most conveniently available at any academic institution, students are the obvious choice for experimental subjects, and consequently are employed by the majority of experimental studies in Finance I encountered. Even if conducting an experiment with students were to limit to some extent the generalisability of the findings, obtaining managers' participation is prohibitively difficult. To address this concern, a good compromise may be to ensure a certain suitability of the students; for instance, Schwarzkopf (2003) selects for his experiment students who have prior investing experience (p.96).

4.2.3 Choice of methodology

The choice of how to best collect data on the existence of managerial overconfidence and regret aversion, and the hypothesized effects of these biases on capital investment decisions should take into consideration the arguments and insights presented in this chapter so far, and evaluate them in the light of the requirements of the present research. Essentially, my methodology should be somewhat hybrid: Establishing the

existence of managerial overconfidence and regret aversion, and the predicted inefficient behaviour can only be done with observations of real-world practice; on the other hand, in order to investigate the proposed association between the biases and certain decision behaviour properly, a relatively controlled environment as in experiments would be ideal. As the analysis of the existing literature in this chapter has shown, experiments are particularly popular for investigating decision processes.

In view all of these considerations, I decided to use a dual approach to data collection by carrying out a survey and conducting experiments as well. Such a strategy is hoped to seize on the benefits associated with either of the two methods in order to meet the challenging data requirements imposed by the research topic, whilst minimizing the individual disadvantages of either experiment or survey alone. Since it was considered a priority to ascertain relatively early on in the research process that a case for managerial overconfidence and regret-aversion could be made, the survey was launched first. In particular, I decided to conduct an internet-based⁴⁹ survey in order to capitalize on the benefits associated with electronic communication. For example, mailing costs were effectively halved since there are no fees associated with the posting of online questionnaires.

In addition, the data from an online survey is available for download in a format that can be directly imported into statistics software such as SPSS. This feature obviously also eliminates any errors that may occur if the responses need to be entered manually into the computer. Furthermore, an electronic questionnaire can be programmed so as to have greater control over the way in which it is completed; for example, participants in the survey can be automatically alerted if any question was not completed properly. In addition, past concerns about internet access and computer literacy inducing a sample bias do not seem so relevant nowadays. Once the first-hand data obtained in the survey seemed to support some of the assumptions and predictions of the model, I began to design experiments to further obtain evidence on the proposed effects of overconfidence and regret aversion on project selection, effort, and project evaluation decisions.

As the earlier review has revealed, experiments have also become more widely accepted in economics and finance in recent years, with the survey of the use of

⁴⁹ Please refer to appendix F for a description of how the survey questionnaire was created and made available to participants.

experiments in this area by Cadsby & Maynes (1998) containing a surprisingly large number of references. An experimental framework was deemed to be fitting for the studied decision stages for at least three reasons. For one, the questionnaire-related hindsight problem, which was already noted for the research by Cooper et al. (1995), could be reduced, as instead of a report of past decision making, experimental data would pertain to behaviour 'as it happens'. In addition, a number of potentially disturbing factors could be excluded. For example, when subjects make decisions on their own account, agency cost problems should be negligible. Reputation or career-related concerns should equally be minimized in an experimental setting. Third, by asking managers questions of the type "do you often make mistakes?" the survey responses could be potentially somewhat insincere with managers wishing to protect their self-esteem. The direct observation of actual behaviour where decisions do not have to be justified should present a useful addition to the survey. In the remainder of this chapter, I now present the survey questionnaire used in my empirical research, as well as the two experiments I conducted.

4.3 Design of the questionnaire

Following on from the preceding discussion, the main objective of the questionnaire was to determine whether overconfidence and regret aversion could be identified among the target group of professionals who make capital investment decisions within companies. Related to this, it was intended that not only the general existence of the studied biases would be checked for, but that the measures for overconfidence and regret aversion should allow for individual differences. As a second objective, the survey should also collect information on how managers make certain choices related to capital investments. Responses to these questions will be used in establishing whether predicted behaviour like late abandonment and over- or under-investment exists in practice.

Further, in combination with the individual overconfidence and regret aversion scores, associations between choice behaviour and psychological factors can then be analysed to provide evidence by which to evaluate the theoretical propositions of the model. A final objective was to explore the extent to which certain important assumptions of my model, such as the alignment of managerial interests with those of shareholders, would hold for the sample.

Overall, the questionnaire can be viewed as consisting of three parts. The first part, entitled 'demographic information' collects general data for characterising the sample. The second part, on 'investment appraisal', contains questions that relate to the three investment decisions of my model. Finally, all questions that a respondent may not be as happy to respond to, such as certain psychometric questions, were placed in a third section named 'your opinion on selected aspects of investing'. Prior to launching the final questionnaire, some minor changes such as reducing the number of page breaks in the online questionnaire and clarifying the wording of some questions, which were encountered during a small pilot of the survey, were implemented. The construction and purpose of the individual questions in the final questionnaire is presented in the remainder of this section.

4.3.1 Psychometric questions

In this sub-section, I outline the questions designed to explore whether the studied biases are prevalent among respondents.

Questions relating to managerial overconfidence

Individual overconfidence is measured with seven variables. This approach as well as the general format of the underlying questions is adopted from Glaser et al. (2003:18ff); however, since the research by Glaser et al. (2003) targeted stock market investors, most of the questions were modified to suit the context of corporate investment decision making. The questions address four phenomena related to overconfidence that were identified in the literature review: Illusion of control, optimism, calibration and the better-than-average effect. In the following, the calculation of each variable is outlined and it is shown how the different variables are combined to yield the individual overconfidence score. The general approach to calculating the value for the individual variables by standardising responses and creating a scale of confidence values was also adopted from Glaser et al. (2003).

Table 4.1: Overconfidence questions

Q12	<i>"The factors that make a project turn out profitable, once it was accepted, are partly controllable and partly down to luck. How much would you say is – on average – down to luck (beyond control)?" [CTRL1]</i>
Q15	<i>"The effort I dedicate to an investment project always significantly increases its chances of success." [CTRL2]</i>
Q16	<i>"Please estimate 80% confidence intervals <5 items, see below>." [CALIB]</i>
Q17	<i>"Please indicate how you would rate the prospects of your company (compared to its competitors, for the medium to long term)." [OPT1]</i>
Q18	<i>"It seems to me that in the stock market, my company's shares are most of the time..." [OPT2]</i>
Q19	<i>"My experience at making investment is..." [CTRL3]</i>
Q20	<i>"In comparison to other managers at your level, doing a similar job (inside and outside your company), what percentage would you estimate to have better skills and ability than you?" [BTA]</i>

For questions 12 and 20, responses are measured using a thermometer scale ranging from 0% to 100%. Such scales have the benefit of allowing for nuances in the responses and are useful when a fine differentiation of answers is desirable. Regarding the interpretation of the responses, in order to allow for potential under-confidence, the mid-point of the scale was assigned a neutral value⁵⁰. The confidence score captured by [CTRL1] and [BTA] was thus calculated as

$$(Eq-4.1) \quad CTRL1, BTA = \frac{50 - answer}{50}$$

⁵⁰ This approach was adopted from Glaser et al. (2003) since it has some intuitive appeal: The two extreme points of the scale clearly represent extreme overconfidence and extreme underconfidence – a manager who does not think that luck plays a role in success may fairly be considered as strongly confident. It is important to note, however, that choosing an absolute and externally determined neutral point is likely to introduce some degree of bias to the results unless it corresponds to the mean or median of the population. For instance, if the true neutral point was greater than the mid-point of the scale, some subjects identified as overconfident may in fact merely display average confidence. One way to remedy this problem is to use the mean or median of the sample as a benchmark for what is over- or underconfident. As this would require quite a large sample, however, and effectively should only result in a shift of the confidence scores, this approach is not adopted here.

A negative value for these variables indicates underconfidence⁵¹, while a value greater than zero indicates overconfidence.

Question 15 asks a participant to indicate the strength of his agreement or disagreement on a five-point Likert scale with the notion that his effort is generally a significant success factor. A respondent who 'strongly disagreed' with this view is assumed to be underconfident, while someone who would strongly agree qualifies as overconfident. The coding of the responses ranges from 1 for strong disagreement to 5 for strong agreement. In order to obtain values for [CTRL2] that are consistent with the defined scale from (-1) for extreme underconfidence to (+1) for extreme overconfidence, the variable is calculated as

$$(Eq-4.2) \quad CTRL2 = \frac{answer - 3}{2}$$

Question 16 measures calibration, but is limited to five instead of the normal ten items in order to reduce the amount of time required to complete the questionnaire. The approach taken here is that of confidence intervals, whereby participants are asked questions to which the answer is a numerical value. However, the questions are of such difficulty that it is unlikely that a participant knows the exact value. For this reason, participants were told to only indicate a value range for each question such that they believe there is only a 20% risk that it does not contain the correct answer; this is called a confidence interval. In my survey, managers were thus required to indicate the lower and upper boundaries of value intervals for which they were quite (80%) confident that the unknown correct value lies within. The five items for which respondents were asked to form estimates are partly adopted from Glaser et al. (2003):

- (a) How many shares of Adidas Salomon AG were traded on the German DAX stock index on 1st October 2003?
- (b) How many cars did BMW AG sell in total (incl. BMW, Mini and Rolls Royce) in the first quarter of 2004?
- (c) How many SHELL petrol stations were there in Germany as of July 2003?

⁵¹ Note that my model does not consider underconfidence, but this might be included for instance by means of a variable that increases the probability of failure with increasing underconfidence.

- (d) How many employees outside of Germany did Deutsche Bank AG have as of 1st January 2004?
- (e) How many medical doctors (excluding dentists) were there in Germany as of December 2003?

Again following Glaser et al. (2003), each interval stated too narrowly is counted as an error point, and the sum of error points over all five questions is used to calculate the calibration measure of overconfidence [*CALIB*] for the participant. With a confidence interval of 20%, a well-calibrated respondent should only commit one error over the five questions. More errors indicate that the respondent was overly confident in the accuracy of his estimate on too many occasions by suggesting too narrow a range of possible correct values on more than one of the five items. The calibration score is therefore calculated as

$$(Eq-4.3) \quad CALIB = 1 - \frac{5 - \text{number of errors}}{4}$$

A well-calibrated respondent, committing only one error over the five estimates, would therefore have a calibration score of zero. In contrast, a calibration score of one would correspond to having stated overly narrow intervals for each item, and is thus viewed as an indication of strong overconfidence; for a respondent with no error, the calibration variable will be negative and thus indicate underconfidence.

For the remaining questions 17, 18 and 19, semantic differential scales were employed. Semantic differential scales consist of opposing adjectives on either side of a seven-point scale (Malhotra et al., 2003:305). In each of the three questions, I assigned adjectives to the scaling points in such a way that the neutrality of the mid-point was made explicit. The coding of the responses ranged⁵² from (-3) to (+3), where the mid-point had a value of zero. The three variables [*OPT1*], [*OPT2*] and [*CTRL3*] were then computed as

$$(Eq-4.4) \quad OPT1, OPT2, CTRL3 = \frac{\text{answer}}{3}$$

⁵² Assignment of the extreme values to the end points of the response scale depended on the logic of the question so that consistency in the calculated confidence scores was ensured.

Based on these measures, I calculate a confidence score for each respondent. Specifically, this level of individual confidence is computed as the mean of the seven presented variables according to (Eq-4.5).

$$(Eq-4.5) \quad a = \frac{1}{7} \cdot (BTA + CTRL1 + CTRL2 + CTRL3 + OPT1 + OPT2 + CALIB)$$

Note that the level of confidence is intentionally represented by the variable $[a]$ so as to highlight the link between this empirical value and my model. Consistent with the definition of the overconfidence parameters, the neutral (unbiased) confidence level is given by $[a = 0]$, and maximum overconfidence is indicated by a value of $[a = 1]$. Underconfidence would be shown by a negative value for the confidence measure. In terms of further statistical analysis, output from non-comparative scales such as this confidence score is often treated as interval or even ratio data (Malhotra et al., 2003:319) and is consequently compatible with many statistical analysis methods. For the purpose of evaluating the predictions on the effects of overconfidence of my model, the individual confidence level will be employed as an independent variable.

Measuring regret aversion

In contrast to overconfidence, there is very little guidance in the literature as to how one might empirically measure individual regret aversion. The approach proposed in the following is thus a pioneering effort, which undoubtedly does not do full justice to the complexity of the bias and should be seen as a basis for further development in future research. As the review of the related literature revealed, it is generally assumed that if people anticipate to feel regret in a given choice scenario, they are very likely to behave in a regret-averse way (Zeelenberg et al., 1997). I thus propose to proxy for the strength of regret aversion by measuring individual self-reported inclination to feel regret in a given hypothetical situation relating to the investment decision process. The questions relating to regret aversion thus investigate the extent to which investment decision makers claim to be concerned about the potential regret they might feel if a certain unfavourable outcome occurs.

The questionnaire contains three questions relating to potential regret (Table 4.2). Questions 21 and 22 are employed to calculate the individual regret aversion score (see below). One unanswered question in the regret literature is whether actions are more regretted than inactions (e.g. Feldman et al., 1999). At a basic level, the two questions thus explore whether regret aversion is likely to induce managers to accept more or

fewer investment projects. More importantly, however, the role of questions 21 and 22 is to find out if and to what extent managers consider regret⁵³ in their decisions at all. Responses to these two questions are recorded on thermometer scales that consist of twenty response points to permit a relatively fine tracing of individual differences in expected regret levels. The regret aversion score [*r*] is computed as the mean of the responses to questions 21 and 22 and will be treated as interval or ratio data. Like the overconfidence score, it will be used in eventual statistical analysis as an independent variable.

Table 4.2: Regret aversion questions

Q21	<i>“How much would you regret not having chosen an investment that subsequently turns out to be very profitable?”</i> [REG1]
Q22	<i>“How much would you regret having chosen an investment that subsequently turns out to be loss-making?”</i> [REG2]
Q23	<i>“The regret about having undertaken a project that subsequently turned out to be loss-making is greatest once the project is terminated, and the total loss is realised.”</i>

Question 23 was included to determine an important property of regret in the context of capital investment projects, namely whether delaying the realisation of a loss would also serve avoiding the pain of regret. Statman et al. (1987) seem to suggest that delaying the pain of regret may lead managers to delay realising losses and to continue investing in failing projects. In this respect, regret aversion might be related to the phenomenon of loss aversion (Kahneman, Knetsch, & Thaler, 1991), which describes the tendency of people to try and avoid certain losses by preferring gambles where a loss is only uncertain. In my model, regret is anticipated and its effect on behaviour depends on outcome observability and not so much on the timing of loss realisation. Question 23 seeks to shed some light on these conjectures. Responses to this question are recorded on a five-point Likert scale measuring agreement.

⁵³ Although intuition tells us that regret is a rather widespread phenomenon, it should be noted that in traditional finance theory, this emotion is not considered at all.

4.3.2 Questions relating to capital investment decision behaviour

Since this is a thesis in Corporate Finance, a great interest of the survey is also on obtaining information regarding how and why managers take certain capital investment decisions. The proposed model of the capital investment decision process covers three decision steps: Project selection, managerial effort and project evaluation. There are obvious limitations⁵⁴ to the extent that actual decision behaviour in these choice situations can be observed using a questionnaire. Nevertheless, the questions presented in the following attempt to overcome these limitations as much as possible.

Project selection

Regarding the decision whether to accept or reject an investment, my model predicts that both overconfidence and regret aversion may lead to inefficient project selection. Yet since a manager may not be aware of his bias, he will not consider his decision to be suboptimal. To him, any project he accepts seems worthwhile, and conversely, every rejected investment seems to be a bad investment. Even in retrospect, if a project failed, an overconfident decision maker may tend to search blame for the failure elsewhere. The resulting difficulty for the formulation of questions is therefore that that respondents lack the objectivity required to decide whether a decision was really good or bad, whilst there is no way of knowing for the non-participating researcher, either. With the intent of bypassing this logical obstacle, I stated question 7 with regard to the past, and introduced in questions 10 and 11 the concept of a third person's NPV calculation that may have been available to the manager at the time he took the project selection decision; whereby this third party is meant to represent a proxy for what is objectively optimal. The three project selection questions are listed in Table 4.3.

⁵⁴ See earlier discussion on the methodological weaknesses of surveys.

Table 4.3: Project selection questions

Q7	<i>"Looking at past forecasts you made, would you say they were typically...[strongly pessimistic to strongly optimistic]"</i>
Q10	<i>"Have you ever accepted an investment project which had been forecast to have a negative NPV, and why?"</i>
Q11	<i>"When would you reject an investment that was forecast to have a positive NPV?" [Other than the case of mutually exclusive projects]</i>

Responses to question 7 are recorded on a seven-point semantic differential scale with a label assigned to each point, coded from one to seven. Possible inferential statistics for this type of interval data thus include product moment correlation and cross-tabulation. In questions 10 and 11, participants choose between several closed-form response-options, representing different possible explanations for the indicated behaviour; otherwise, Q10 and Q11 would observe the 'how', whilst in this form, they also investigate the 'why'. In addition, there is an open text response field added to each question to let participants provide alternative reasons than the ones suggested. Data from the two variables is nominal, and can hence be analysed through cross-tabulation and the chi-square test statistic.

Managerial effort

Managerial effort, due to the difficulties associated with assessing this type of decision in a survey, is proxied for by information search effort. Given that this is effort required to make informed decisions and thus can be assumed to have an effect on the probability of success, this approximation⁵⁵ is justifiable. Information search is measured by question 9 (see Table 4.4 below), which requires respondents to indicate on a standard five-point Likert scale their agreement with the statement in Table 4.4. The resulting coded responses from this question can thus be treated as interval or ratio data (Malhotra et al., 2003:319).

⁵⁵ See also my earlier discussion of Cooper et al. (1995).

Table 4.4: Effort question

Q9 *"Prior to making an investment decision, I require putting in a lot of research and analysis to reduce uncertainty as much as possible."*

Project evaluation

The questionnaire furthermore collects information on managers' project evaluation decision behaviour. However, a respondent objectivity problem similar to the one discussed for project selection arises also in this context. It can be assumed that few managers will say that they would not abandon a project that should be terminated. Of course, if they continue to invest this means that they believe the project is worth continuing. Hence, all a questionnaire can do is enquiring about past instances in which the manager may have realised, and is willing to admit, having made an inefficient project evaluation decision. In view of this complication, I formulated question 13 as relating to the evaluation of a decision in retrospective⁵⁶. The purpose of this question is thus merely to determine if the manager is aware of past sub-optimal decision behaviour, irrespective of its motivations at the time. Consequently, the data expected from this question will be nominal and will permit an analysis of differences in mean overconfidence and regret aversion for the two (yes or no) respondent groups.

Table 4.5: Project evaluation question

Q13 *"Did you ever keep investing – at least for some time – in a project where immediate (early) abandonment⁵⁷ would have been cheaper than continuation?"*

⁵⁶ Note that with this approach there is a potential risk of the responses being influenced by hindsight bias: Even if a manager feels in retrospective that he should have made a different evaluation decision, was this also what would have been objectively optimal at the time, given the information available then?

⁵⁷ Note also that I confined the survey investigation on project evaluation to the case of inefficient continuation, as observing inefficient abandonment would be quite impossible to identify in reality.

Other / control questions

My theoretical propositions and the models make several assumptions about managerial motivations and behaviour. For example, I assume that managers pursue the maximisation of shareholder value. This assumption is a relatively important building block of my propositions because without such intentions on the part of the capital investment decision makers, any deviations from what is normatively optimal that might be found from the responses could simply be attributable to managerial selfishness. Controlling for the alignment of interests of managers with shareholders is therefore relevant to probe for any likely interference of a moral hazard issue. In order to address concerns of this nature, I have included questions in my survey that should deliver evidence pertaining to such assumptions underlying my models and the hypotheses. Table 4.6 lists the different questions.

Questions 5 and 14 are designed to assess the role agency cost theory as a driver of reported decisions. If managers respond in question 5 that they have a personal stake in their companies' equity, I take this as evidence of a weak moral hazard problem. The purpose of corporate equity plans is to motivate managers to act in the best interests of shareholders by making their salary or wealth depend on the price of the company's stock, too. Although there can be no guarantee, I assume that such methods are fairly effective in reducing managerial shirking and value destroying decisions. Given the importance of agency cost models, results from question 5 are further backed up by responses to question 14. In addition to probing for the model assumption of shareholder value maximisation as the overall aim of managers, that question also allows a cross-check with the inferences from the agency cost control question: If an individual indicates owning corporate equity but still does not seek to maximize shareholder value, different kinds of questions would arise. In particular, not all managers who do not own company stocks automatically need to be selfish. They might still be pursuing shareholders' best interests, something that question 14 is designed to explore. Question 14 contains a five-point Likert scale, while responses to question 5 are limited to a straightforward yes-or-no question.

Proponents of traditional finance might argue that managers who are not selfish should be expected to make optimal decisions. However, if one assumes a more human image of corporate decision makers, it is conceivable that they may be trying to act in the best interest of shareholders but simply do not manage to. The theory of bounded rationality (Simon, 1955) suggests in broad terms that there may be external limits to

optimizing behaviour, or internal limits imposed by the function of the human psyche. The purpose of question 24 is therefore to obtain an indication of which theory managers find more descriptively accurate of their investment decision behaviour, rational optimising or boundedly rational satisficing.

The remaining two questions, Q6 and Q8 also link to this idea of satisficing behaviour, and should also be interesting in conjunction with the responses on the importance of shareholder value. Questions 6 and 8 both investigate aspects of corporate finance decision making which may be quite time-consuming. A manager who tries to make optimal decisions should always use the NPV method and calculate an individual discount rate for each project. Any other behaviour recorded by these two questions would therefore support the notion that, for whichever reason, managers do not or cannot behave fully rationally.

Table 4.6: Control questions

Q5	<i>"Do you own shares or stock options in the company you are working for (with respect to your investment decision making)?"</i>
Q6	<i>"Which of these methods do you choose for the financial appraisal of an investment project?" [Choice from a list of different methods]</i>
Q8	<i>"How do you determine the discount rate for appraising an investment project?" [Choice from a list of different techniques]</i>
Q14	<i>"My aim is that every investment I promote or select will increase shareholder value." [Agreement]</i>
Q24	<i>"Which of the following statements best reflects your overall approach to investment decisions?</i> <i>(i) Time and effort are very costly. Once a proposed investment meets my requirements (e.g. positive NPV, profitability level), I do not continue to search for a potentially even better investment that may exist.</i> <i>(ii) I devote considerable effort to making sure I can compare as many acceptable projects as possible so that I can select only the best</i> <i>(iii) None of the above"</i>

4.4 Presentation of the experiments

In addition to the survey, and with regard to its inevitable methodological limitations, I also designed and conducted two different experiments to collect further empirical evidence for evaluating the model predictions. This section details the set-up of the experiments and the underlying rationale. Experiment 1 provides a simple framework for studying the effect of overconfidence on project selection and individual effort. Experiment 2 is designed to permit an investigation of a potential effect of regret aversion on the decision whether to continue or abandon an existing investment. In both experiments, students are used as experimental subjects and receive performance related rewards after the experiments. Rewards are paid out in cash or as vouchers; this alternative to cash payments was introduced for ethical considerations by arrangement of a voucher scheme with the on-campus supermarket.

4.4.1 Experiment 1: Project selection, effort and overconfidence

This experiment tries to provide a context in which investment project selection and effort level decisions of subjects can be observed. In addition, by applying the concept of skill-rank dependent success probabilities (Camerer et al., 1999), individual confidence levels are simultaneously observed. In this set-up, subjects' expected pay-offs from their investment choices are dependent on self-assessed (relative) ability and knowledge. Another source of inspiration in the design of the experiment were Heath & Petersen (1996) who induce uncertainty using a random event for which they determine only ex-post which of two probability distributions will apply to the evaluation of the different strategies. The experimental subjects thus know the space of permissible probability distributions, but do not know which one will apply. In my experiment, it is each individual participant's rank based on performance in a simple general knowledge (pub) quiz that determines which of the two probability distributions will be used. Uncertainty about the probability of success is thus linked to uncertainty about own relative knowledge and performance, and ultimately therefore to individual confidence.

Hence, in this experiment, and consistent with the literature in psychology, it is uncertainty that causes the interference of psychological biases. The analysis of the model has shown that overconfidence may cause excessive effort, since overconfident individuals overestimate the benefits from their effort contribution relative to the cost

of effort. In addition, the model predicts that overconfidence should be associated with overinvestment in the sense that overconfident individuals invest in projects that have a negative NPV. The aim of this experiment is to investigate these two predictions empirically by exploring whether the hypothesised behaviour can be observed in the laboratory, and if it can be shown to be associated with measures of individual confidence. The independent variable in this experiment is thus individual confidence, and the dependent variables are the number of projects accepted by a participant (project selection behaviour) and the level of effort. Individual confidence is measured using ten calibration questions, as well as using the accuracy of self-estimated performance in relative and absolute terms. Effort is for the benefit of simplicity limited to a binary variable, hence participants exert effort, or they do not. The procedure of the experiment is described in sequence below.

At the beginning of the experimental session, subjects are assured that the experiment does not affect the marks or grades for their degree course and that individual responses would be treated confidentially by the experimenter. In addition, subjects are told that the ten best performing participants will receive prizes. The experiment is then introduced as consisting of the following two parts. In a first step, subjects complete the 'test questionnaire'. They begin by responding to twenty questions in a general knowledge quiz. Subjects are told that their performance in the test will affect the probability with which their investment decisions later on would be successful. This feature represents the idea of rank-dependent success probabilities (Camerer et al., 1999).

Out of the twenty questions, however, only ten are actual quiz questions. They comprise multiple-choice general knowledge questions and simple calculus exercises. The remaining ten questions of the quiz are confidence interval questions; they were included to assess individual overconfidence scores but this is not disclosed to participants. Following the quiz and the confidence interval questions, subjects are asked to evaluate their own performance in the twenty knowledge questions in absolute and in relative terms. In addition, two simple gambles (Figure 4.2) are proposed as a way of accounting for individual risk preferences.

Figure 4.2: Risk preference questions

Q4.4 Please indicate which option you would prefer in each case

- (i) 500 pounds for sure OR a 45% chance of winning 1,000 and nothing otherwise
 - (ii) 500 pounds for sure OR a 55% chance of winning 1,000 and nothing otherwise
-

The idea behind these questions is that respondents who prefer the safety equivalent in both cases can be classified as risk-averse, and respondents who choose to gamble in both cases as risk loving. Someone who prefers the certain cash payment in the first choice pair but chooses to enter the gamble in the second proposal is assumed here to be weakly risk-averse or risk-neutral. The final questions in this first section of the experiment record a respondent's gender and email address (for contacting the prize winners). Fifteen minutes are allocated for this first part of the experiment.

The second part of the experiment contains the actual investment decision task for which subjects have to make an investment decision in combination with an effort decision for a given budget. Another fifteen minutes is allocated for this second part of the experiment. Responses are recorded on the experimental handout, which is collected at the end of the experiment. Subjects are reminded that in order to qualify for a prize, this second section has to be properly completed. The basic structure of the investment task is as follows:

- Subjects initially dispose of a virtual budget of 10 monetary units (MU). In the first period, subjects make two interdependent decisions. For one, subjects must decide how much of their budget they wish to invest in the uncertain projects. Each project requires an investment of 2 MU, so that subjects can invest in at most five of the investment projects⁵⁸. However, subjects are also given the option to expend 2 MU as 'effort' to improve the probability with which the projects will be successful. Given the budget constraint, making this payment reduces the amount disposable for investment so that only four projects can be invested in if effort is chosen.
- If a subject does not make any investments in the first period, and does not pay for 'effort', his final wealth position at the end of the game will simply be his original

⁵⁸ Projects are identical.

budget of 10 MU. In contrast, if a subject invests in one or more projects, his final wealth depends on the cash flows from the investment(s). These, in turn, depend on which state of nature will occur in the second period.

- The realisation of the state of nature depends on performance in the ten knowledge questions, and whether a participant purchased the ‘effort’ option in period one. In terms of test performance, I distinguish between the top quartile and the rest, whereby the success probability for the top quartile is greater. As for the effort choice, the probability of success is greater when effort was bought. The resulting four possible probability distributions, illustrated in Figure 4.3 below, are available to participants in the experiment already in period one. Since subjects can only estimate their individual ranking in the test, they are uncertain which probability distribution applies for them⁵⁹.

Figure 4.3: Probability of success for different groups of subjects

	<i>No effort</i>	<i>Effort</i>
<i>Top-quartile</i>	0.50	0.83
<i>Rest</i>	0.33	0.50

- In the good state, each project delivers a cash flow of 4 MU. Under the bad state of nature, each project fails and results in a negative cash flow of (-1) MU. To facilitate subjects’ decision-making, payout information is stated in a table in terms of net present values per number of projects chosen. For illustration, investing in two projects would have a bad-state NPV of (-6) MU and a good-state NPV of 4 MU.

Assuming that subjects will base their investment decision on the expected net present values for the different choice options, they will need to estimate which probability distribution is most likely to apply for them. Hence, in this experiment individual investment decisions depend to a large extent on how well subjects believe they fared in the quiz compared to all the other experimental candidates. Consequently, the observable decision behaviour (effort choice, number of projects invested in) should depend on an individual’s level of confidence. Hereby, individual confidence is measured using two variables. The use of confidence intervals in measuring overconfidence was already introduced in the presentation of the survey questions.

⁵⁹ Uncertainty in an investment game is also induced in this way by Heath et al. (1996).

Now, in this experiment, subjects respond to ten instead of five questions, and are set an 80% confidence level. As a result, the first measure of individual confidence in this experiment is

$$(Eq-4.6) \quad S_1 = 1 - \frac{10 - errors}{8}$$

In addition, having completed the quiz section, subjects are asked to assess their performance in relative and in absolute terms. These assessments can then be compared against actual performance to determine the accuracy of self-perceived performance. Someone who thinks he has done well while in fact he has not will be deemed to be overconfident, and underconfident in the opposite case. The second measure of confidence is hence calculated as the mean level of perceptive accuracy for relative and absolute performance.

$$(Eq-4.7) \quad S_2 = \frac{1}{2} \cdot \left[\frac{(x_{est} - x_{act})}{100} + \frac{(y_{est} - y_{act})}{4} \right]$$

where x_{est}, x_{act} : Percentage of questions correct, estimated and actual
 y_{est}, y_{act} : Relative performance scaled from well below average (-2) to well above average (+2), estimated and actual

For the neutral point (no over- or under-confidence), each of the measures takes a value of zero. Positive values indicate overconfidence, with the maximum level at (+1); negative values indicate under-confidence, with the minimum level of confidence at (-1). While the overall experimental design is aimed at testing the effect of overconfidence on project selection and effort in general, determining individual confidence should – assuming there are individual differences in behaviour – enable a finer analysis, particularly for analysing different degrees of potential over-investment.

4.4.2 Experiment 2: Project evaluation and regret aversion

This second experiment is aimed at studying the effect of regret aversion on individuals' decisions whether to continue or abandon a given investment (project evaluation). As outlined previously, it is optimal to abandon an investment when the expected value with continuation is less than that obtainable with termination. Allowing for managerial regret aversion, my model predicts that project evaluation

decisions may deviate from this normatively optimal behaviour. In the model, it was assumed that the continuation value would only be observable (ex-post) with actual continuation of the investment; on the other hand, the value obtainable with immediate termination of the investment was assumed to be always observable ex-post (type 2 partial outcome observability). Under these assumptions, the model predicts that aversion to regret is conducive to premature abandonment in the sense that investments that ought to be continued may be (sub-optimally) terminated. However, whilst the model assumed a risk-neutral decision maker, people in reality are assumed to be generally risk-averse.

This likely difference between theory and practice regarding risk-preferences poses a potential problem for empirical testing: Project termination would not only be consistent with the model prediction for regret aversion, but also with simple risk aversion. As a result, it would be very difficult to decide if observed project abandonment decisions are evidence to support the hypothesis of an effect of regret aversion. A way of overcoming this problem is to modify the feedback condition following Zeelenberg et al. (1997:15) so that the risk-averse choice is different from the regret-averse choice.

In my model, this step can be accommodated simply by assuming the mentioned type 1 partial outcome observability, under which the continuation value is always observable ex-post but the abandonment value is only observable for actual termination of the investment. Such a manipulation leads to an inversion of the model prediction, such that regret aversion should now favour project continuation. In contrast, regret aversion would still lead to project abandonment. The experimental framework presented in the remainder of this section aims to test this prediction and follows largely the experiment reported by Zeelenberg et al. (1996).

The experiment follows a post-test-only control group design, which is a true experimental design (Malhotra et al., 2003:271). Subjects are randomly attributed to one of two groups, and one group receives a treatment. The treatment effect is then studied by comparing the post-treatment observations for both groups. The general task for both groups is identical. Subjects are told to picture themselves as corporate finance managers in a medium-sized company. In addition, they read the following scenario description:

"There is one investment project which has serious problems; in fact, things are so bad that the CEO has asked you to think about whether the project should not be

abandoned immediately – after all, it was you who initially assessed the proposal and recommended to start investing in this particular project."

The subsequent choice options (continue or abandon) are outlined and also summarized in a simple pay-off table (Figure 4.4). The expected values for the project are chosen such that any unbiased risk-neutral or risk-averse individual⁶⁰ should prefer abandonment of the project.

Figure 4.4: Project evaluation set-up

<i>Decision</i>	<i>Probability</i>	<i>Outcome</i>
<i>continue</i>	0.2	0
	0.8	-235,000
<i>abandon</i>	0.5	-170,000
	0.5	-200,000

Following these explanations, the experimental handouts contain additional information regarding the observability of the outcomes. This information represents the treatment, and is thus different for each group. The treatment in this experiment is adopted from Zeelenberg et al. (1996) although in the present experiment there are only two instead of three different feedback conditions. Subjects in the control group are instructed that only the outcome of the option they choose will be observable to them and the fictional CEO of the company. Hence, if they continue the investment, they will not find out what outcome they could have achieved had they decided to terminate the project instead, and vice versa. Since there is no counterfactual feedback in this condition, there should be no regret associated with either choice option.

In contrast, the instructions for subjects in the treatment group tell them that if they chose to abandon the project, the outcome of the foregone action (continuation) would be observable ex-post, whereas if they chose to continue the project, no feedback on the outcome for abandonment would be received⁶¹. The treatment condition thus consists of asymmetric feedback as in Zeelenberg et al. (1996) such that the regret-minimizing option (avoiding feedback) is the uncertain choice (continuation), whilst

⁶⁰ Individual risk preferences of subjects are measured prior to the actual investment decision by means of a choice between two gambles.

⁶¹ In other words, the abandonment option is assumed to be unobservable (ex-post) under continuation.

the low-risk option (abandonment) is associated with potential ex-post decision regret. Subjects in the control group should thus behave consistent with their risk preferences, and given that people are typically risk-averse, one would expect a significant proportion favouring the risk-minimizing option of abandonment. If anticipated regret had no impact on behaviour, then roughly the same behaviour should be observable in the treatment group, as the treatment of inducing regret aversion should be ineffective (null-hypothesis). However, assuming the existence and behavioural influence of regret aversion, subjects in the treatment group should behave in a regret-minimizing yet in the present set-up a risk-seeking fashion, which should be inconsistent with their risk preferences (unless they are natural risk-seekers anyway). At the end of the experiment, subjects are also asked to indicate the reasons underlying their decision.

4.5 Summary

In this chapter, the chosen data collection methods were presented and justified. The purpose of the methods is to gather empirical data by which the predictions of the theoretical model can be evaluated. Following some general epistemological considerations, as well as a review of the research methods used in the related literature, a two methods research strategy is retained. The importance of the validity and reliability of findings in a research design that is oriented towards positivism is reflected by the preference for surveys and experiments in past finance research. By combining these two methods for my empirical research, I hope to mitigate the identified weaknesses of either approach whilst building on the combined strengths. The construction of the survey questionnaire and the purpose of individual questions, as well as the approach for administering the questionnaire were outlined. In addition, the purpose and sequence of events of the two experiments that were designed for this research project were presented. The next chapter reports on the data that was collected with these methods and presents the results of the statistical analysis.

CHAPTER 5: DATA COLLECTION AND ANALYSIS

Subsequent to the presentation of my model in Chapter 3, I discussed possible options how data to evaluate the model propositions might be collected in Chapter 4; I concluded that a survey in combination with experiments would be the most appropriate data collection methodology. Accordingly, I conducted a survey of managers who make capital investment decisions using the questionnaire detailed in the previous outline of the methodology. Additionally, following the two different experimental designs I proposed, I conducted experiments to investigate any causal link between the phenomena of overconfidence and regret aversion on one side, and reported decision behaviour at the three identified decision steps of the capital investment decision process.

In this chapter, I describe how the different methods were implemented and present the empirical results. As a function of the dual methods research strategy, the present chapter consists essentially of two building blocks. In the first part, I present the findings from the survey on managerial overconfidence, regret aversion, and selected capital investment decisions. I also report the results of inferential statistical analyses conducted to investigate eventual associations between biases and behaviour. In the second part, the experimental findings for the two conducted experiments as described in the preceding chapter are presented. This chapter closes with a discussion of the limitations of the findings.

5.1 Evidence on corporate decision makers: The survey

In this section, I present the findings from the analytical, cross-sectional survey that I carried out using the internet-based questionnaire presented in the preceding chapter. The online questionnaire was accessible through a dedicated internet address that remained open for a total duration of eight months starting in January and closing in August 2005. On an ongoing basis throughout this period, I sent out invitations to participate to corporate finance decision makers, largely at chief financial officer

(CFO) level, at the UK's largest manufacturing⁶² companies. Contact information for the target group was drawn from the FAME database. Only companies for which it could be assumed that their business activity required substantial tangible assets (real capital), and hence that important capital investment decisions were likely to be made, were considered. In a first step, thus, companies were ranked according to asset size. For practicality reasons, companies for which the FAME database did not contain at least a name for a relevant manager were excluded from the sample. Companies without an internet-address were also excluded since no detailed checks on their activity and management could be made in an efficient manner.

The managers' full names and corporate addresses as obtained through the FAME database were then checked against company information from the Hoovers.com database as well as individual corporate websites. In this process, incomplete or false mailing details were eliminated, resulting in a final database of 350 corporate contacts. The letters invited the managers to participate in the survey and provided details of how to access the online questionnaire. Strict anonymity and confidentiality were asserted in the text. The letters also explained that for each received questionnaire, one pound would be donated to Cancer Research UK, which was hoped to provide an incentive for participants to take part in the survey.

In addition, an invitation to participate in the survey was also posted to alumni of the University of Bath's MBA programme via the electronic Alumni magazine. This was done in order to obtain more responses following signs of a very low participation from contacted managers despite several 'waves' of contacting. However, to address the problem of a potentially less homogenous respondent group, the required profile in terms of capital investment experience was emphasised in the invitation mailing to the MBAs. What may thus be seen in a strict sense as a dilution of the original target group can be justified by the argument that capital investment decisions are often part of the responsibility of non-financial managers. It was felt that as long as participants had relevant experience, job descriptions were of a lesser importance.

Overall, from the around 350 letters to corporate managers, as well as the contacting of Bath MBA alumni with relevant experience, a total of 57 responses to the survey questionnaire. However, only 34 questionnaires were sufficiently completed, resulting

⁶² The reasoning behind the focus on the manufacturing industry was that the type of capital investment decision investigated by this research would be unlikely to be taken by companies that operate without significant plant or machinery.

in an estimated response rate of around 10%. Although such a response rate is comparable to other and larger surveys, the relatively large number of only partially completed questionnaires for this survey is surprising. The average response time here for the completed questionnaires was just short of eight minutes⁶³; given that this is shorter than the estimate indicated in the invitation letters, the questionnaire was arguably not too lengthy but actually achieved its objective of being efficient to complete. The many incomplete responses may, however, be explained by the fact that questionnaires were mostly aborted when participants encountered the first set of psychometric questions.

Based on the responses to the demographic questions, the respondent sample can be characterised by some selected demographics. All thirty-four respondents are male. The majority of them (60%) are younger than forty-five years of age, and only about 10% are older than fifty-five. Respondents are quite heterogeneous regarding their academic backgrounds. Around a third holds a bachelor's, and another third a master's degree. The remaining third of participants in this survey either successfully completed an MBA or a PhD programme, or have some other form of degree not specified⁶⁴. Over two-thirds of the respondents describe their job role as being grouped within their organisation as a finance function. All others may not formally belong to the finance departments of their companies, but can be assumed to have nevertheless experience in making capital investment decisions; for example, investment decisions may be placed within the area of responsibility of an operations or corporate development manager. In addition, some of the respondents from the MBA group may currently not be actively working in a finance function despite having experience of investment appraisal.

5.1.1 Drivers of managerial decisions

The traditional view in corporate finance theory assumes that managers behave rationally but may be inclined to pursue their own interests instead of purely

⁶³ While participation in the survey was not overly time-consuming, the average completion time is also long enough to refute criticism that respondents simply rushed through the questions and selected answers at random. Hence, although the sample is of limited size, the collected responses can safely be assumed to be of a reasonable quality in the sense that they represent respondents' considered views and experiences.

⁶⁴ My respondent sample is thus slightly younger than the CFOs who responded to the large-scale survey by Graham & Harvey (2001:193), but similar in terms of education levels.

maximizing shareholder value (moral hazard). In the model, I assumed that there is no conflict of interests but that the decision maker always seeks to act in the best interest of shareholders. Evidently, whether this assumption holds or not for the sample is relevant for the interpretation of the responses to the investment decision questions. Given the importance of this assumption, there were two questions to control for possible moral hazard concerns. In question 14, respondents were asked to what extent they aimed to maximize shareholder value with their decisions. Almost 90% of the participating managers claim taking their investment decisions in the pursuit of shareholder value maximisation.

Naturally, it may be argued that this finding is flawed because managers want to be seen as maximising shareholder value even if they are not; for this reason, it is interesting also to consider the responses to question 5, which investigated if a respondent participated in the company's equity in some form. Arguably, being a shareholder to some extent should lead to a motivation to pursue shareholder interests. The responses from my sample indicate widespread equity participation for the sample, with 90% of respondents owning shares or stock options in the companies they are working for. I therefore propose that the companies represented by the respondents have largely addressed the moral hazard problem, and that the assumption of the responding managers pursuing shareholder interests is plausible. Hence, the response data shall be viewed as being largely free of any bias related to the principal-agent conflict of interests and can thus be compared to the normatively optimal benchmark of rational investment decision making.

Interestingly, however, the responses to Q6 and Q8 on how the participating managers select investment projects appear to be in conflict with the principle of shareholder value maximisation. As my data shows, the managers in the sample use investment techniques that for a long time have been shown by academics to lead potentially to value-destroying capital allocation decisions. Only about one-third consider the net present value of an investment project; the second most popular appraisal technique is payback (25% of respondents), followed by return ratios such as return on investment or return on assets (16%), and the internal rate of return (15%). The data also shows that managers generally rely on combinations of these techniques when deciding whether to reject or accept an investment project. As far as discounting is concerned, around 40% of respondents in my sample apply a standard discount rate across different projects; only 50% at least subjectively risk-adjust this rate, and a mere 3%

calculate an individual rate for each project. Such behaviour is inconsistent with traditional finance theory, according to which only the NPV method should be relied upon, yet has also been noticed in larger surveys (Graham et al., 2001; Pike, 1996).

The observation that managers who on the one hand say they would like to maximize shareholder value, but who on the other hand make important decisions on the basis of methods that have for a long time now been criticized in Finance, is somewhat paradoxical. In trying to understand this theory-practice gap, Arya, Fellingham, & Glover (1998:499) poignantly summarize that

"...one of two conclusions can be drawn: (1) firms are making sub-optimal decisions or (2) the assumptions underlying the NPV rule are not always met in practice."

As I explained in the first chapter, one of the central assumptions on which the normative status of the NPV method hinges is the perfectly rational, optimizing behaviour of the decision maker. In response to question 24, one-third of respondents indicated that they could not fully optimise due to constraints of time and resources. Following Herbert Simon (1955), such perceived bounds to rationality may be caused by the fact that human information processing is not as perfect as assumed by standard theory. These responses may thus be seen as support of the notion that managers struggle with the same imperfections of the human brain as everyone else. If one accepts this argument, it does not seem to be too far-fetched to conjecture that corporate capital investment decision makers are also subject to psychological biases like overconfidence and the aversion to feeling regret just as everyone else is.

5.1.2 Evidence of psychological biases

Following the finding that several participating managers, although they wish to act in the best interest of shareholders, may simply not be able to do so – potentially due to bounds to full rationality – I now present in detail evidence obtained from the psychometric questions suggesting that the two studied psychological biases of overconfidence and regret aversion are indeed prevalent for the sample group. Prior to presenting these findings and using them in the statistical analysis, however, attention must be drawn again to the specific way in which overconfidence and regret aversion are measured here. In particular, and as noted previously in the methodology chapter, several measures of the two psychological biases employ neutral points (to define benchmarks of unbiased preferences) that are not relative to the sample or the

population but simply represent the mid-points of the respective scales (as opposed to using for instance the mean of the sample as the rational choice). Whilst this does not have a significant impact on the general findings of the data analysis, it should be remembered that individual degrees of overconfidence or regret aversion are relative to these subjectively determined benchmarks rather than the sample group.

Overconfidence

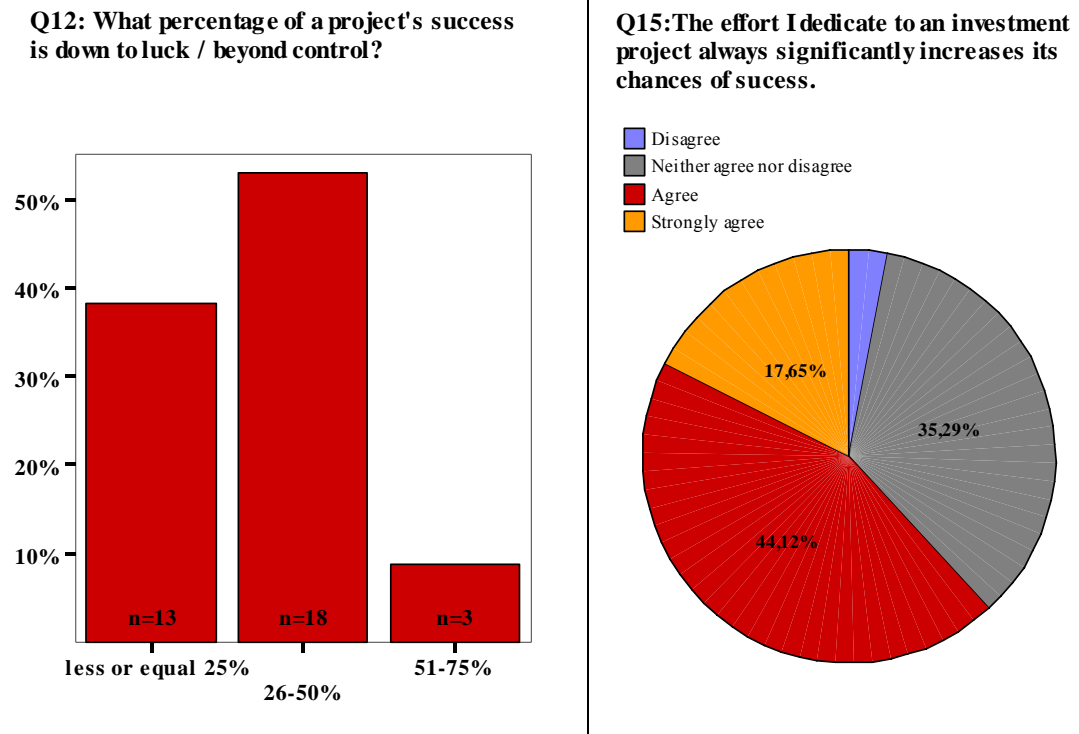
Based on the definitions presented in the literature review, overconfidence is measured for each individual respondent using several psychometric questions that were adopted in modified form from Glaser et al. (2003). The questions probe for the existence of a range of psychological phenomena⁶⁵ that are theoretically symptomatic of respondent overconfidence. Two objectives are pursued with these questions. First, it is evident that finding out if managers who make capital investment decisions are indeed prone to overconfidence is crucial to the relevance of my models and their predictions; the main purpose of the overconfidence related questions is hence to deliver evidence by which the existence of the bias can be verified. Additionally, measurements of individual levels of overconfidence will be used as the independent variable for simple statistical analyses of relationships with other variables that pertain to the proposed hypotheses.

A first ‘symptom’ of overconfidence, the illusion of control (Langer, 1975), was investigated by two questions that were designed to capture the extent to which managers believe that they can control the outcome of an investment project. Question 12 measures the subjectively perceived importance of chance in success as perceived by the respondents. I find that the majority of respondents believe that chance accounts for less than 40%. More than a third of respondents even feel the outcome of a capital investment project depends to over three-quarters on factors they can control as opposed to mere chance. Consistently, fewer than 10% of participants seem to think the part beyond control of an investment is greater than a half. These findings are illustrated by the bar chart in Figure 5.1. The second question related to the perceived control over a project’s outcome asked participants to state the extent to which they agree that their effort input to an investment project “always significantly increases its chances of success” (Q15). My analysis of the responses shows that about 60% (cumulatively) of respondents agreed or strongly agreed with this statement;

⁶⁵ For a detailed presentation of these questions, please refer to Chapter 4 on the research methodology.

disagreement was only indicated by one individual. The detailed frequencies can be seen in the pie chart in Figure 5.1. On the grounds of these observations, I thus propose that most respondents display a strong feeling of control, which may be illusory or not, but is certainly congruent with the notion of strong confidence.

Figure 5.1: Illusion of control diagrams



Source: Own survey data, analysis with SPSS

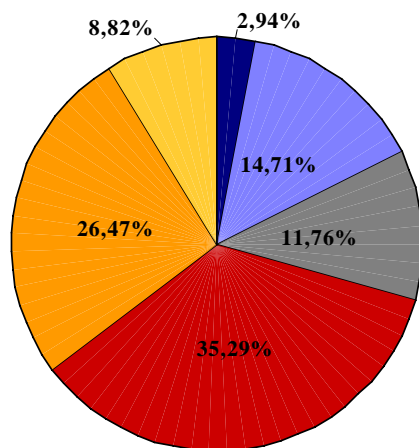
In addition to the illusion of control, a second feature of overconfidence identified in the literature review is an overly positive view of oneself, one's abilities and skills, both in absolute and in relative terms. Individual beliefs with respect to this better-than-average effect were investigated by questions 19 and 20. Evaluating their own experience by completing the statement "my experience at making investment decisions is..." (Q19), a cumulative 35% of participants selected "very high" or "high" as a response; about 70% (cumulatively) indicated that they felt they were 'above average' regarding their investment decision making experience. Overall, only 18% rated their expertise as below average. In a subsequent question (Q20), respondents had to rank themselves by indicating the percentage of peers they believed having better skills and ability. Half of all participants, on a cumulative basis, claim that there are only about 20% of colleagues who are superior to them. In other words, 50% of the

respondents believe they are among the top fifth in their peer group. In contrast, no one deemed themselves to be in the bottom quarter of their peer group. Again, despite individual differences, these findings of widespread strikingly positive self-images tend to support the idea of managerial overconfidence for the respondent sample. Figure 5.2 displays the summarized responses in graphical form

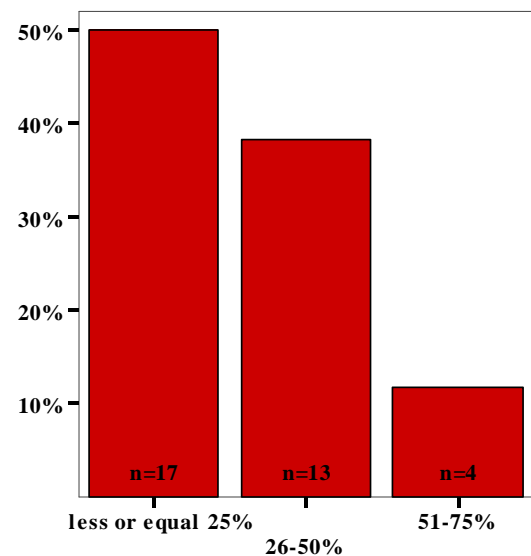
Figure 5.2: Self-image diagrams

Q19: My experience at making investment decisions is...

- Low
- Below average
- Average
- Above average
- High
- Very high



Q20: In comparison to other managers [...] what percentage would you estimate to have better skills and ability than you?



Source: Own survey data, analysis with SPSS

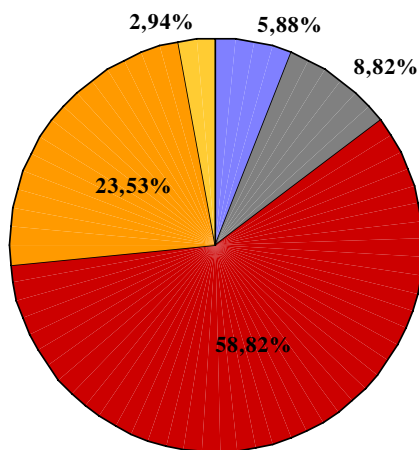
A further robust conclusion of the literature on overconfidence is its association with unrealistically positive expectations of the future, that is, systematic optimism. In this survey, participants' degree of optimism was measured by asking managers to indicate how they viewed the prospects of their company compared to its competitors in the respective industry (Q17). The results are once more skewed, supporting the pervasiveness of optimism: Cumulatively, over a quarter of respondents believe their companies' prospects to be somewhere between 'far better than average' to 'superb'. A further 60% feel their company is better than average. Yet since this optimism is not necessarily unfounded (particularly in view of a small sample), I included question 18 which makes reference to the stock market's view of the company. Arguably, the market is always correct, or at least reflects the opinion of several others: The finding that more than one-third of the participants think the stock market undervalues to some

extent their companies' shares "most of the time" must imply that these respondents think they know better than many other people; moreover, they also think that others have an overly negative outlook on the company's ability to create value in the future. At a general⁶⁶ level, and in the absence of information asymmetries, this evidence thus provides yet another indication that managerial overconfidence is given for my sample.

Figure 5.3: Optimism diagrams

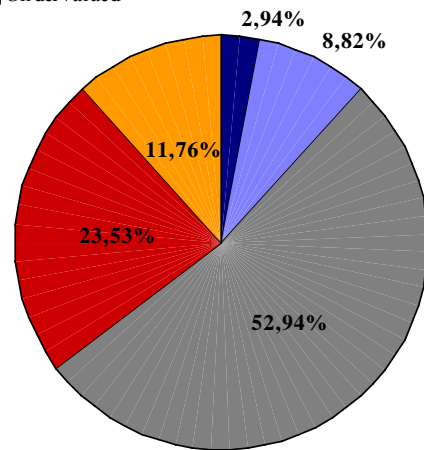
Q17: How would you rate the prospects of your company compared to its competitors?

- Slightly below average
- About average
- Slightly better than average
- Far better than average
- Superb



Q18: It seems to me that in the stock market, my company's shares are most of the time...

- Overvalued
- A little overvalued
- Fairly priced
- A little undervalued
- Undervalued



Source: Own survey data, analysis with SPSS

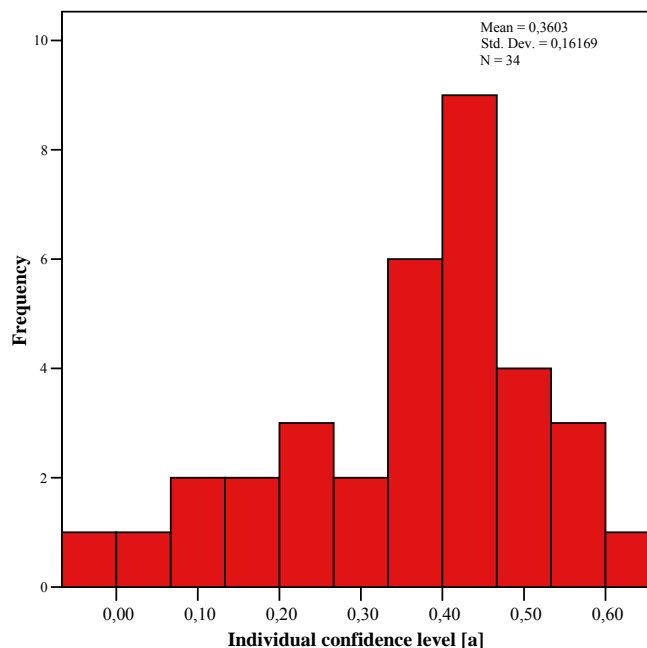
In a final approach to measuring participants' confidence levels, this questionnaire contained one question requiring participants to estimate confidence intervals (Q16). The different items, presented in detail in the preceding chapter on the research methodology, are a commonly used technique to assess whether people 'know how much they know' (meta-knowledge). Deficient meta-knowledge, in the sense that someone thinks he knows more than he actually does, is generally taken as evidence of overconfidence. This method thus distinguishes between different levels of overconfidence based on how many confidence intervals were stated as too narrow (number of errors). Since question 16 asked for 80%-confidence intervals, a well-calibrated (unbiased) individual would be expected to commit only one 'error' over the

⁶⁶ To their credit, though, 50% of respondents felt their stocks were fairly priced, and around 12% even though they were overvalued to some degree.

five intervals in this question. Hardly anyone achieved this target, though. With around 40%, three errors were most frequent. About one third of the participating managers were wrong in their judgement on 4 or more out of the ten questions. These results show that most of the respondents overestimated the accuracy of their own knowledge, thus qualifying as overconfident by this measure.

To summarize, the presented responses to the overconfidence questions seem to indicate a widespread existence of managerial overconfidence for the respondent sample. Even though the scales of most of the measures also extend into the negative domain, thus potentially allowing for individual under-confidence, this applied to only one respondent, while for the remainder of the sample non-negative values for the individual confidence level [$0 \leq a \leq 1$] were observed. The distribution of the individual confidence scores is shown by the histogram in Figure 5.4. The neutral point (no over- or underconfidence) is set at zero, with overconfidence increasing along the horizontal axis.

Figure 5.4: Histogram of individual confidence levels



Source: Own survey data, analysis in SPSS

The distribution is clearly negatively skewed (-0.656): While some managers are only weakly overconfident, most of the participants are found to have medium to upper medium overconfidence levels, resulting in a median of $\bar{a} = 0.39$. In spite of the

skewness, however, a Kolmogorov-Smirnov test showed that the distribution of the individual confidence levels corresponds reasonably well to a normal distribution (p-value of 0.42) so that further statistical analysis may justifiably employ methods that assume a normal distribution of individual confidence as an independent variable.

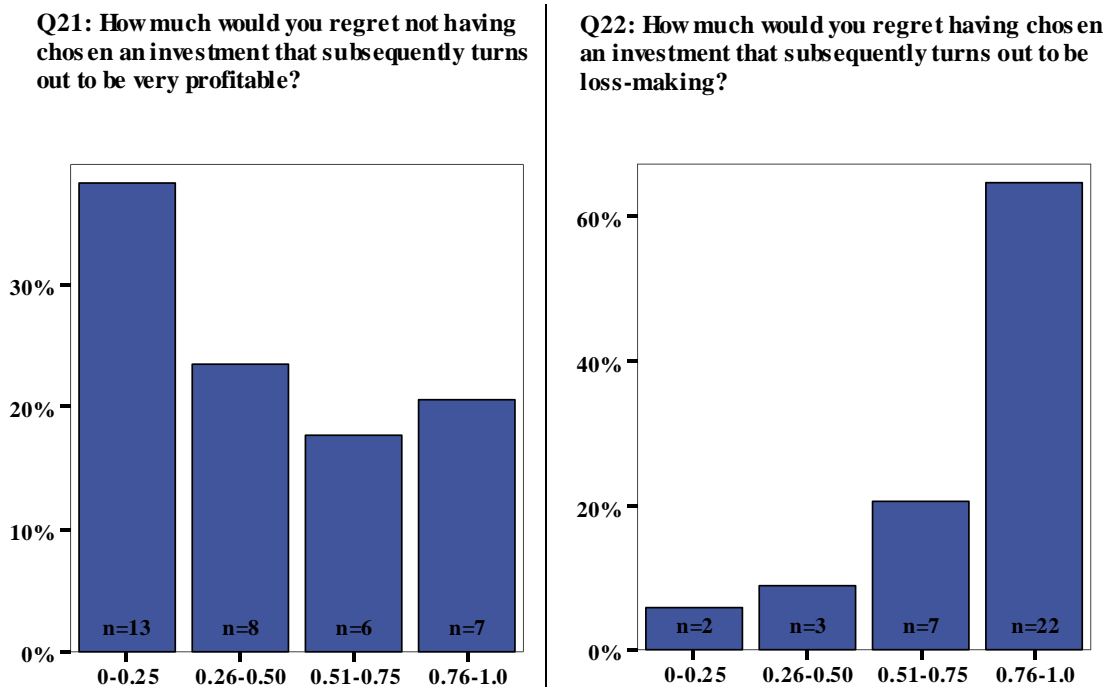
Aversion to regret

The second psychological bias investigated in this research is regret aversion. A central aim of the survey was to establish if regret aversion is of any relevance in the context of managerial capital investment decisions. I am not aware of any existing published research that would have attempted to measure the individual degree of regret aversion of managers. In the absence of guidance from any prior research, the approach taken here focused on establishing whether the emotion of regret is given any consideration by the targeted managers when they make capital investment decisions; I thus simply assume that once someone anticipates feeling regret, he will also be keen to avoid or minimize the expected disutility. As outlined in the presentation of the structure of the questionnaire in Chapter 4, the survey contained three questions in relation to the emotion of regret.

Of particular interest are questions 21 and 22 because they represent the components of my calculation of the individual regret aversion score. In question 21, respondents indicated how much they would regret having foregone an investment and subsequently learning that it turned out to be very profitable. Even though it is quite normal to feel bad about having missed out on a good opportunity, such a feeling is not rational as it is derived from a hypothetical situation. Yet only two of the participating managers alleged that they would feel no regret at all if they found out that they had ignored a chance to increase shareholder value; most of the respondents acknowledged that they might feel some regret, even though only weakly so. Almost 12% even admitted that they would feel very strong regret (>0.75) upon learning that they had failed to take on a good investment. The corresponding alternative to failing to seize an investment opportunity is failure to reject a bad investment. The degree to which this decision outcome would be regretted was explored in question 22. Over half of the respondents indicated that in the case of having invested in a bad project, they would feel fairly strong regret (>0.6). The frequency diagrams of the grouped responses for the two scenarios are juxtaposed in Figure 5.5.

It is interesting to note the difference in the aggregate responses to the two questions; apparently, participants expect to suffer on average less from the regret of having failed to invest in a good project than from that of having invested in a bad project. This finding is consistent with research in psychology that argues that, at least in the short term, regret of having committed oneself to a failing course of action may be greater than regret of omission (Gilovich, 1995). Overall, however, the main finding to be retained is that the participating managers do consider potential regret when making capital investment decisions and that the extent to which they expect to experience this regret differs at the level of the individual.

Figure 5.5: Bar chart of responses to question 21 and 22

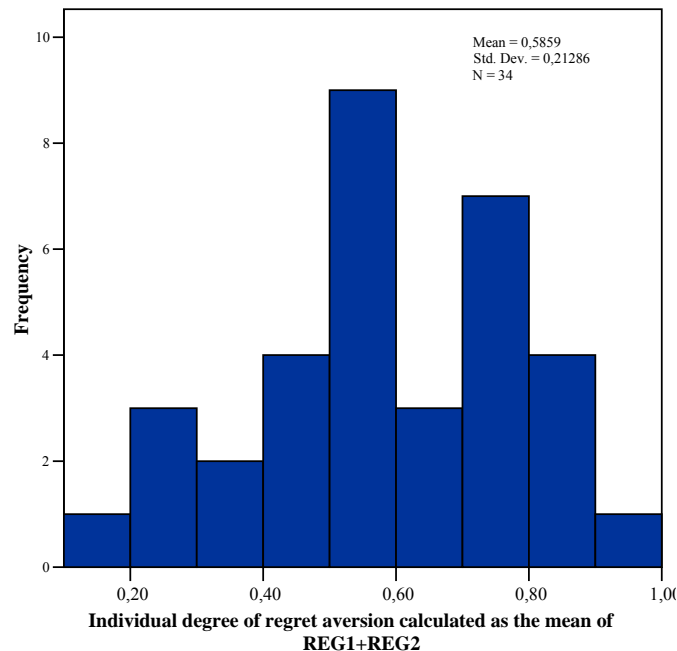


Source: Own survey data, analysis with SPSS

Since the two variables (Q21 and Q22) are measures of the intensity to which respondents anticipate to feel regret, it is possible to calculate an individual regret aversion score as proposed in Chapter 4 by taking the mean of the individual responses to these two questions. This derived variable takes values from zero (no regret aversion) to one (maximum regret aversion). The distribution, shown by the histogram in Figure 5.7, is slightly negatively skewed (-0.387) and platykurtic (kurtosis of 0.524). A mean of $[\bar{r} \approx 0.6]$ indicates that at least for this sample, the individual propensity to suffer from the pain of regret is relatively large. A Kolmogorov-Smirnov test

conducted for the individual degree of regret aversion suggests that further analysis may reasonably assume this variable to be normally distributed.

Figure 5.6: Histogram of individual regret aversion



Source: Own survey data, analysis with SPSS

The third question relating to the extent to which managers are prone to experiencing regret in their capital investment decisions related to the time when the disutility of regret may be most intensely felt. In question 23, managers were asked to indicate their agreement on a five-point Likert scale with the notion that regret was greatest once a project was terminated with the total loss being realised. Mixed responses were received to this question. A cumulative 44% of participants agreed with the statement, yet about 28% stated some degree of disagreement. About a quarter of respondents were ambivalent ('neither agree nor disagree'). How should these results be interpreted? At a general level, the responses show once again that regret does affect some managers' investment decisions. Further, the finding that regret is not necessarily greatest when losses are realised could be interpreted as suggesting that regret is anticipated and thus unrelated to the concept of loss aversion. However, during the analysis of the responses, I also realised that this question is stated in a way that may be ambiguous to respondents. It must therefore be acknowledged that due to shortcomings in the design and formulation of question 23, which had not surfaced earlier, any interpretation of the responses is limited.

5.1.3 Capital investment decisions in practice

Having established the existence of overconfidence and regret aversion among the managers who participated in my survey, it is now possible to take the analysis one step further by looking into the hypothesized interactions between psychological factors and capital investment decisions. This section thus focuses on evaluating some of the model predictions for the possible effects of individual overconfidence and regret aversion on project selection, effort and project evaluation decisions. For each of the three decision steps, it is first ascertained if indicated choices conform to the model predictions before discussing to which degree this behaviour may be explained by either overconfidence or regret aversion.

Project selection

The project selection decision was defined to involve the choice between accepting and rejecting an investment project. Optimal project selection means accepting only investments with a positive NPV and rejecting all investments with a negative NPV. My model proposes that both overconfidence and regret aversion may cause over-investment; the main driver behind this is a systematic overestimation of the value of any investment: Overconfidence has this effect because of a biased perception of the degree to which effort can impact the chance of success; in turn, regret aversion leads to greater effort, and ultimately to a higher subjectively expected value for an investment because of an underestimation of the continuation value. A joint prediction for the two biases is thus that expected project values should be systematically biased, and this seems to be confirmed by the survey evidence.

In response to question 7, the vast majority of the participating managers disclosed that their past forecasts have indeed on average tended to be too buoyant in retrospective. Only about 18% of respondents allegedly make forecasts that are typically more on the pessimistic side. Hence, at a descriptive level, the empirical evidence appears to be consistent with the model prediction of systematically biased valuations. On this basis, it is justified to test for the predicted association between project selection, and overconfidence and regret aversion, respectively. This analysis draws on the data obtained from questions 10 and 11. In question 10, participants were asked if they had ever accepted an investment with a negative NPV, while in question 11 they were asked if they had ever rejected an investment with a positive NPV. In the following, I

examine in turn the explanatory power of overconfidence and regret aversion regarding this evidence on project selection decisions.

Project selection and overconfidence

My model predicts that overconfidence should typically lead to an overestimation of the expected value of an investment, unless the effort-reducing effect of optimism is dominant; consequently, an overconfident manager may accept investments that should be rejected. In addition to the suggested response options in question 10, respondents were also given the opportunity to explain why they would *accept* an investment project that had been deemed to be *value destroying*. For the statistical analysis of the association of overconfidence with responses to question 10, it is necessary to group and recode the different obtained explanations. Broadly, these can be subsumed under four headings: Regulatory requirements (environmental or legal), strategic benefits, IT projects, and use of a different appraisal technique. Not all of these explanations are necessarily valid reasons for inefficient project selection decisions, though, and a closer inspection is appropriate.

For instance, it would seem that an investment that was undertaken because of its fit with corporate strategy should still only be accepted if it is expected to yield a positive net present value (NPV), as it is unlikely that any corporate strategy would imply value destruction. Therefore, I argue that managers who try to excuse the decision to accept an investment with a negative NPV for 'strategic reasons' are providing an invalid⁶⁷ rationale for their decision; the same argument applies to accepting of allegedly 'necessary' investments in information technology that have a negative expected NPV. Consequently, these respondents are counted towards the group that would accept a bad investment (response group 'yes'). In contrast, respondents who had said they had never accepted a negative NPV project, or had only done so very exceptionally and with a compelling reason⁶⁸, were counted in a second response group ('no'). Data

⁶⁷ Such behaviour fits better with the overconfidence hypothesis: Too convinced by his personal beliefs, the overconfident manager ignores result of the quantitative appraisal and purports a vague concept such as strategy to go ahead with the project. Exemplary of this behaviour is one manager's comment on why he would accept an investment despite its negative NPV: "sometimes you know it just makes business sense".

⁶⁸ Following the preceding discussion, explanations relating to IT or corporate strategy were not accepted as genuine.

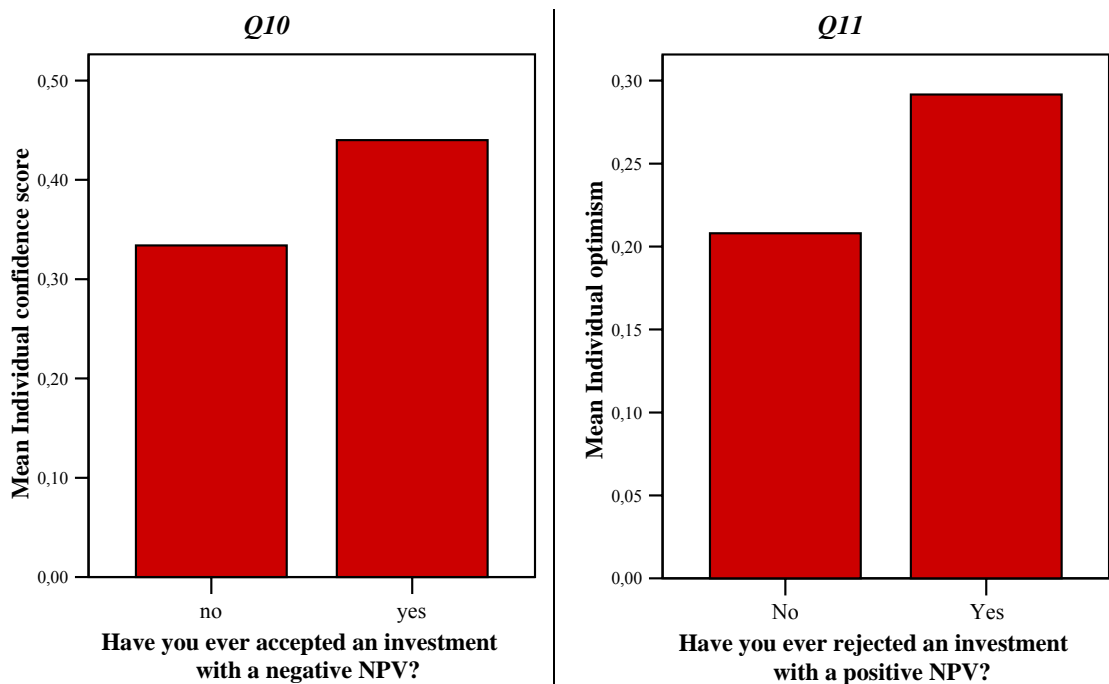
which could not be attributed⁶⁹ to either condition was omitted, resulting in a reduced data set of $n=30$. For these two groups, the difference in mean individual confidence score $[\bar{a}]$ will be used to test the null hypothesis against the alternative hypothesis:

$$H_0 : \bar{a}_{yes} = \bar{a}_{no} \quad (\text{no difference})$$

$$H_1 : \bar{a}_{yes} > \bar{a}_{no} \quad (\text{greater overconfidence})$$

The bar chart on the left in Figure 5.7 illustrates the mean individual confidence score for each group. As the diagram shows, the average individual confidence level is greater for those who said they had accepted an investment with a negative NPV ('yes'). An independent samples t-test on the difference between the mean overconfidence scores for the two groups shows that this difference just fails to be significant at the 95% confidence level with a value of $p = 0.092$. Yet although the null-hypothesis of no association thus cannot be rejected, it should be noted that the direction of the difference is consistent with the proposition that overconfidence may be positively associated with overinvestment.

Figure 5.7: Overconfidence and project selection decisions



Source: Own survey data, analysis with SPSS

⁶⁹ This included mainly respondents who stated that they used some other method (except those using IRR, which is related to NPV and should thus in most cases lead to the same decision).

Question 11 addressed the opposite potential decision error of deliberately not accepting an investment that had been forecast (by an unbiased individual) to deliver a positive net present value. At first glance, it must be noted that a considerable number of participants said that they had indeed rejected a good project for one or the other reason. Besides a lack of strategic fit, another frequently given explanation for knowingly foregoing a good investment relates once again to the use of different appraisal techniques. For example, one respondent explained that he would reject a project that had a positive NPV if it did not meet his requirements in terms of payback. In addition, participants named financing constraints as a reason why they would reject an investment with a positive NPV. For the purpose of analysing the role of overconfidence, it is once again necessary to separate valid from less convincing arguments.

In this context, not accepting an investment that does not fit corporate strategy is quite reasonable. There are numerous investment opportunities in reality, and clearly only relevant ones should be considered. Respondents who named strategic fit as the only reason why they would not pursue a profitable investment are thus considered to have a valid excuse. In contrast, when it was claimed that an investment had been rejected for a lack of internal funding, it is suggested that this is not a valid reason; funding can, at least in theory, be obtained externally⁷⁰. Respondents who said that they did not use the NPV method were excluded from the analysis consistent with the approach used for grouping open responses to question 10. Hence, following this reasoning, all respondents who replied to question 11 with open text were attributed to either one of the two groups.

A comparison of the mean individual confidence scores between the two groups showed that they are almost⁷¹ identical. However, this is not surprising since potential underinvestment with overconfidence is in my model more likely for overconfidence regarding the state of nature (optimistic overconfidence) alone. In order to explore this aspect of the model, I calculated a mean optimism score (as the mean of the two optimism components [*OPT1*] and [*OPT2*] of the overconfidence measure) for the two groups, illustrated by the bar chart on the right in Figure 5.7. The diagram shows a

⁷⁰ See also Heaton (2002) who predicts that a high cash flow sensitivity of corporate investment may be indicative of managerial overconfidence.

⁷¹ The mean individual confidence score for those who said they had not rejected an investment with a positive NPV ('no') is 0.37 and that of the other group ('yes') is 0.34.

higher mean individual degree of optimism for those respondents who admitted that they had foregone a good project. Whilst this finding appears to support my model, the difference in optimism between the two groups is not large enough to be statistically significant (t-test, 95%, $p=0.475$).

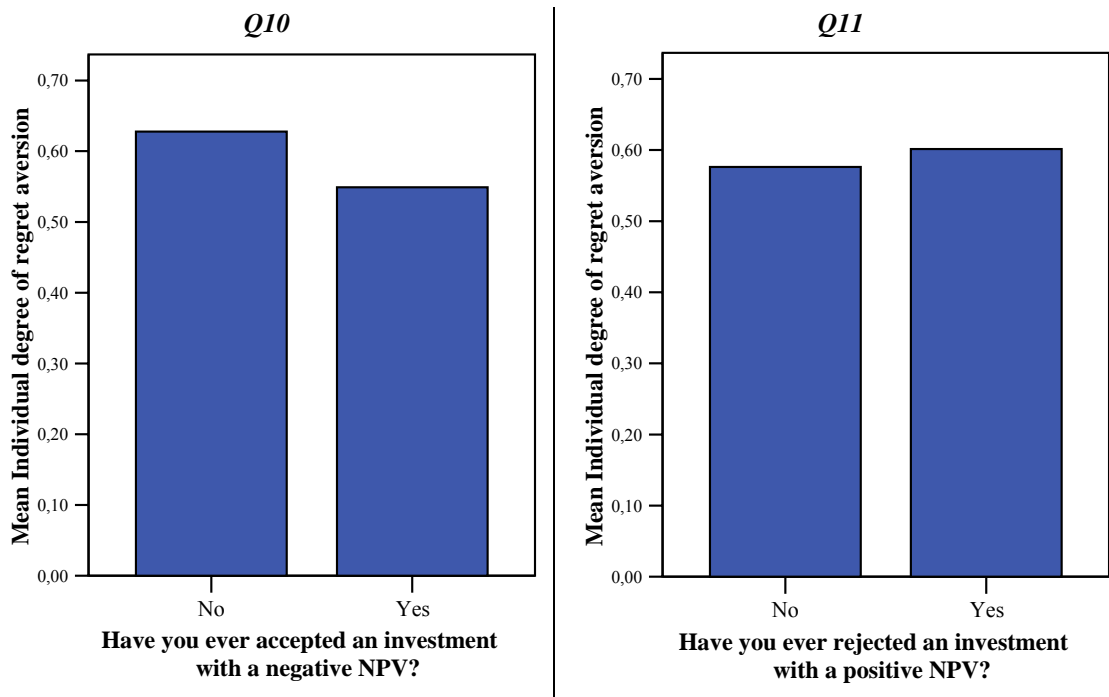
Project selection and regret aversion

Concerning the effect of regret aversion, my model predicts that it may lead to either over- or underinvestment since the effect on the expected value of an investment depends on the specific parameters of an investment. To shed some light on this proposition, I compared the mean individual regret aversion score for the two respondent groups derived from the responses to questions 10 and 11, respectively. The hypotheses to be investigated in this analysis can be stated with reference to the mean individual regret aversion score $[\bar{r}]$ as:

$$\begin{aligned} H_0 : \quad & \bar{r}_{yes} = \bar{r}_{no} \quad (\text{no difference}) \\ H_1 : \quad & \bar{r}_{yes} \neq \bar{r}_{no} \quad (\text{some difference}) \end{aligned}$$

The two diagrams in Figure 5.8 present graphically the calculated difference in mean individual regret aversion for the groups of questions 10 and 11. In the diagram on the left (Q10), the mean regret aversion is greater for those respondents who claimed to never have accepted an investment with a negative NPV. However, this difference is not statistically significant.

As for the diagram on the right (Q11), it is apparent that there is almost no difference in the mean individual regret aversion scores for the two groups. Consequently, the null hypothesis of no difference cannot be rejected. Given that the model predictions for the effect of regret aversion on project selection depend to a large extent on specific values for the expected cash flows as well as the cost of effort of a given investment, the lack of a significant association for this data does not weaken the model either.

Figure 5.8: Regret aversion and selection groups

Source: Own survey data, analysis with SPSS

Managerial effort

Since managerial effort in the management of an investment project is somewhat difficult to measure⁷², the construct of effort was proxied for in the questionnaire by the notion of collecting information about an investment project in order to make informed decisions (Q9). Responses to question 9 were expressed in terms of agreement (on a five-point preference scale) with the notion of typically exerting high information search effort. In the absence of neutral answers, it is possible to group respondents in either one of two groups. Those who disagreed or strongly disagreed with the idea of high effort ('No') can thus be contrasted against those who agreed or strongly agreed ('Yes') with the view stated in question 9.

I find that most of the participating managers (70%) expressed agreement with their generally requiring a lot of information search effort. Given the social desirability of effort, these responses might particularly be criticised as inaccurate. However, in approximating the potential role of the 'social desirability' bias, it is worth noting that responses to other investment decision related questions demonstrate that survey participants were not shy of admitting to theoretically sub-optimal behaviour at all. It

⁷² See section 4.3.3 for the presentation of question 9.

is thus assumed here that the recorded responses are largely reflective of actual behaviour, and that the complete anonymity guaranteed to participants may have been effective in mitigating the effect of the ‘social desirability’ bias.

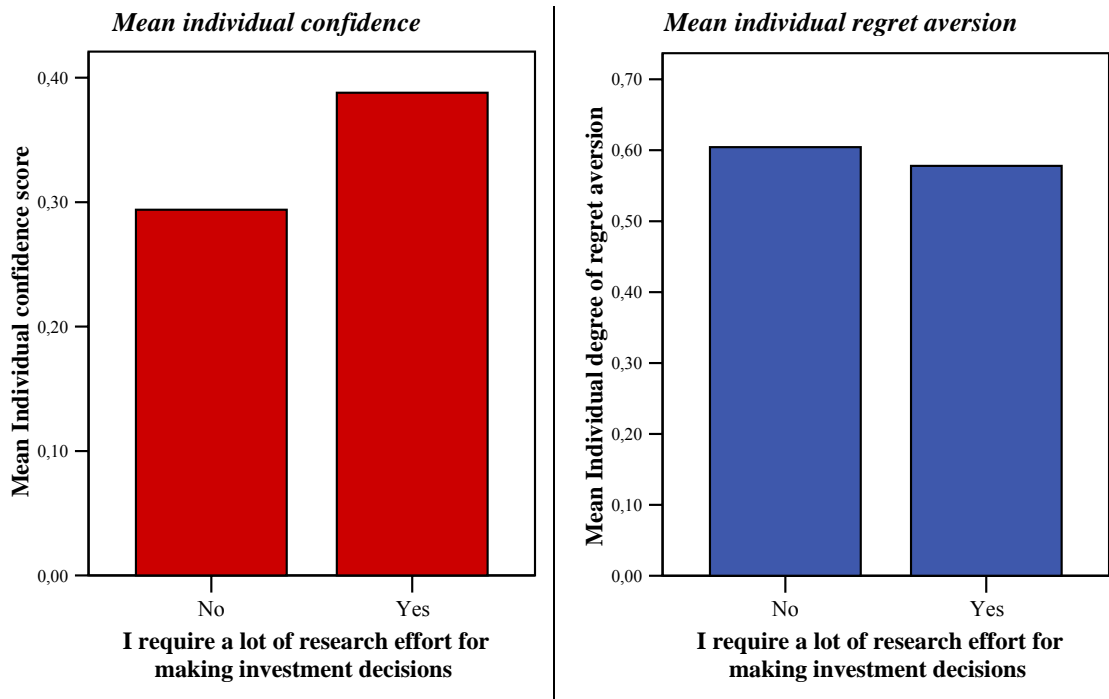
Using normatively optimal behaviour in its descriptive form as a benchmark again, individual confidence levels should not affect the effort level decision (null hypothesis). Regarding overconfidence, my model predicts that it should lead to higher effort unless the effort-reducing effect of optimism is very strong. For managerial regret aversion, the prediction is that it should unambiguously induce higher effort. The set of hypotheses can hence be written as:

$$H_0 : \bar{a}_{yes} = \bar{a}_{no} \quad ; \quad \bar{r}_{yes} = \bar{r}_{no} \quad (\text{no difference})$$

$$H_1 : \bar{a}_{yes} \neq \bar{a}_{no} \quad ; \quad \bar{r}_{yes} > \bar{r}_{no} \quad (\text{some difference; greater regret aversion})$$

To investigate these propositions, I compared the grouped responses to question 9 with regard to their mean individual confidence and mean individual regret aversion scores, respectively. The results of this comparison are illustrated in Figure 5.9.

Figure 5.9: Effort with overconfidence and with regret aversion



Source: Own survey data, analysis with SPSS

The apparent difference in mean individual confidence for the two effort level groups depicted by the bar chart on the right in Figure 5.9 is consistent with the notion that

overconfidence should be associated with greater effort. Yet once again this difference is *not* large enough to be statistically significant ($p=0.124$).

With respect to the mean degree of individual regret aversion, the diagram on the right in Figure 5.9 clearly shows that there is virtually no difference between the two groups. The null hypotheses for the effort level thus cannot be formally rejected.

Project evaluation

The third step of the capital investment decision process studied by this research is the project evaluation decision. Here, the assumption is that an investment has turned out to be loss making and the decision maker therefore needs to assess whether a turn-around on the investment is feasible. Based on a comparison of the NPV of either of the two options, the manager must decide whether to continue or to abandon the investment project. In reality, such an evaluation decision involves significant uncertainty and is largely based on expectations, which is why one may assume a strong influence of psychological biases. My model predicts that overconfidence should induce an overestimation of the value of the investment if it were to be continued, and thus potentially lead to late abandonment. In contrast, regret aversion should have the directly opposite effect, (inefficient) early termination.

Empirical evidence to investigate these propositions was collected in the survey by asking participants if they were aware of their continuing investing when early abandonment would have been cheaper (Q13). Somewhat surprisingly, about 60% of the respondents admitted that they had continued to invest in a project that – at least with hindsight – ought to have been abandoned. Hence, well over half of the survey participants stated that they had taken the very type of sub-optimal decision that is predicted for overconfidence by my model. I thus propose to investigate the following hypotheses:

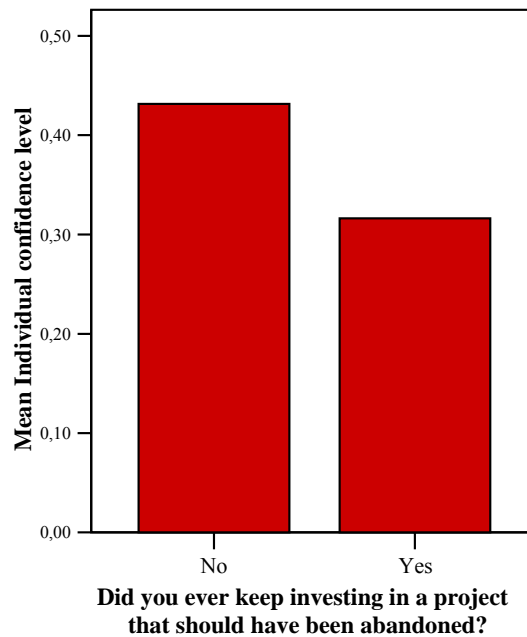
$$H_0 : \bar{a}_{yes} = \bar{a}_{no} \quad (no\ difference)$$

$$H_1 : \bar{a}_{yes} > \bar{a}_{no} \quad (greater\ overconfidence)$$

The comparison of the two mean individual confidence levels for the two project evaluation groups yields the rather unexpected result that mean overconfidence is greater for those who claim *not* to have ever kept investing in a failing project than for those who admit that they have (see Figure 5.10). In other words, those managers who said they had continued an investment in the past for too long are on average less

overconfident that those who claim to have never made this decision error. This finding is significant ($p=0.041$, 95%) but conflicts with the prediction of the model; according to the model, the relationship should be the exact opposite as greater overconfidence is predicted to potentially cause over-investment.

Figure 5.10: Overconfidence and project evaluation



Source: Own survey data, analysis with SPSS

How may this result be explained? Aside from the general limitations of the survey findings due to sample size or methodology, a simple explanation could be that managers who feel more confident are less concerned about making a difficult decision; perhaps so because due to their excessive confidence in their own ability, they genuinely do not view anything to be their fault but more readily find the blame elsewhere.

However, this is mere speculation and not substantiated by the interpretation and modelling of overconfidence in the present work. Future research, however, may benefit from considering these observations in developing an advanced understanding of the different facets and effects of overconfidence.

5.2 Evidence from Experiment 1: Overconfidence in project selection and effort choice

In this section, I present and analyse the observations from my experiment on project selection and effort level decision behaviour with individual overconfidence. Regarding these two choice problems, my model predicts that overconfidence should lead to (i) inefficiently high effort and (ii) inefficient overinvestment. Limited support for these propositions was received by the survey data; the experiment reported here was conducted to investigate further these hypothesized relationships by observing individual effort and project selection decisions in conjunction with individual overconfidence levels in a relatively controlled environment. The main task for subjects in this experiment was to decide how much to invest of a fixed budget, and if so, whether to allocate some of that money to 'effort' or not. These choices were made under uncertainty because related cash flows depended⁷³ effectively on an individual subject's own (unknown) score in a knowledge quiz relative to the (also unknown) results of all other participants.

The data reported here was collected during three experimental sessions, although the bulk of the observations was made during a session conducted at the end of a lecture in Corporate Finance at the School of Management of the University of Bath on 12 May 2005 for which attendance was voluntary. Subjects were students at Master's level who had attended corporate finance lectures in the past, and who should thus be assumed to be familiar with the concept of investment appraisal and the net present value method. There were a total of thirty-six participants, of whom 26 were female and 10 male. Thirty-three correctly and fully completed response forms were retained from this first session. In order to increase that number, a repetition of the experiment was conducted⁷⁴, at which an additional eleven individuals participated, resulting in a total of forty-four observations of individual effort and project selection decision making overall.

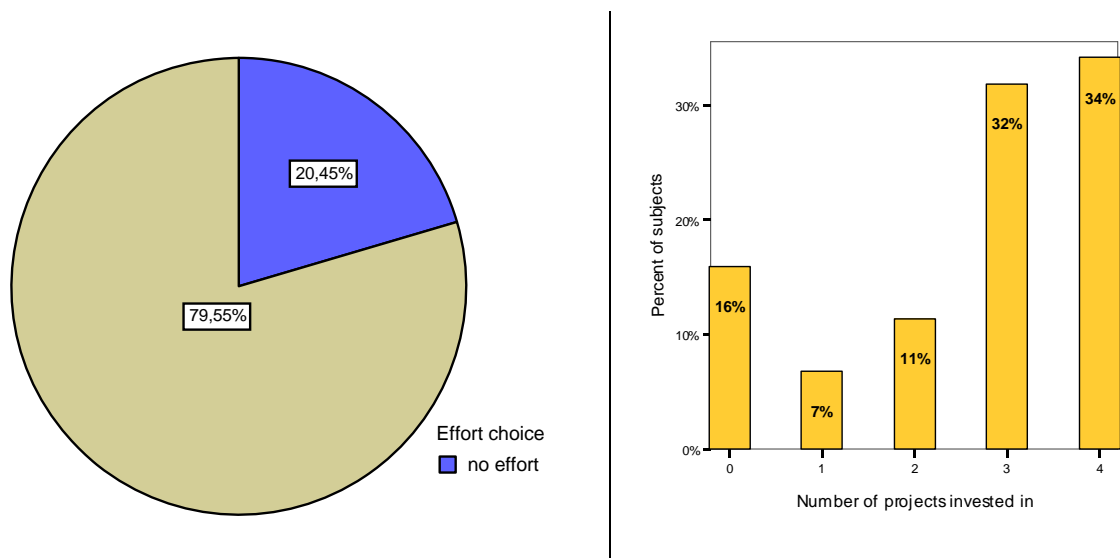
⁷³ This method of inducing uncertainty by means of skill-dependent success probabilities was adopted from Camerer et al. (1999).

⁷⁴ Two sessions were held on 2 and 3 November 2005. Participants had been recruited via an invitation sent by email to students and selected staff at the University of Bath School of Management, who can thus be assumed to have a reasonably good understanding of the different concepts involved in this task.

An initial look at the data shows that the behaviour of most participants is inconsistent with how decisions should be taken, so that the observations are in conflict with what one would descriptively expect if traditional normative decision rules were adhered to. Under the set-up of the experiment, only the top quartile of participants can expect⁷⁵ a positive NPV from investing. To maximize their expected pay-offs, these individuals must choose to exert effort by making a one-off payment, and then invest all remaining funds by selecting four projects. For all other subjects, the expected net value of investing (with or without effort) is negative, and consequently they should not invest (nor exert effort). Hence, if subjects were well calibrated, it would be expected that (i) the proportion of subjects who choose effort as well as (ii) the proportion of subjects who invest are equal to one quarter.

However, the observed choices are substantially different from this optimal behaviour. Only six out of the initial thirty-three subjects, and only two out of the eleven participants from the second experiment did not invest. Just one third of those who invested also followed the maximisation strategy by selecting four projects, and not all investment decisions were accompanied by effort. These findings are illustrated in Figure 5.11.

Figure 5.11: Effort and project selection choices in the experiment



Source: Own experimental data, analysis with SPSS

⁷⁵ Assuming risk-neutrality or risk-aversion. A simple risk profiling of the subjects shows that 45% were risk-averse, 27% risk-neutral, and a further 27% risk loving.

The data thus show over-investment in the sense that many subjects invested although they only stood to lose money. Quite obviously, these decisions were sub-optimal assuming that subjects were interested in maximising their pay-off, had understood the task and were taking the experiment seriously. Since the experiment was designed in such a way that investing and exerting effort only made sense for someone who had done better than at least three quarters of all others in the quiz, the most plausible⁷⁶ explanation for the observed behaviour is that over 80% of the subjects must have believed themselves to be among the top quartile of test performers. At an aggregate level thus, the experiment has achieved to demonstrate that overconfidence can lead to overinvestment. Furthermore, given that only 20% of participants chose not to exert effort although it was not worthwhile for the entire bottom 75% of quiz performers, there is also evidence of general excess effort. These findings are also consistent with what is predicted for overconfidence by my effort model.

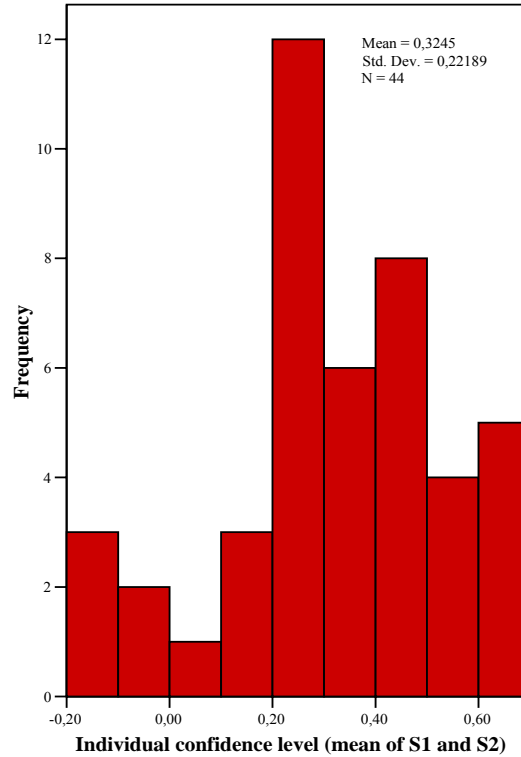
A stronger test of the predicted effect of overconfidence on individual effort and project selection choices, however, must consider the strength of association between the individual observations for the different variables. The independent variable in this analysis is individual confidence, which was captured by two different measures, one inferred from subjective confidence intervals [S_1] and the other from the mean accuracy⁷⁷ of the self-perceived absolute and relative performance [S_2]. A highly significant positive correlation between these two confidence measures was found. Therefore, for the ensuing analysis, individual confidence levels are calculated as the mean individual values of the two measures. The unbiased level of confidence that a well-calibrated agent with good meta-knowledge would have is defined as zero. A score greater than zero indicates overconfidence and a score lower than zero under-confidence. The distribution of the data, (Figure 5.12) can be assumed in the further analysis to be approximately normally distributed according to a Kolmogorov-Smirnov test.

⁷⁶ Individual risk preferences were also recorded in this experiment (Q4.4). About half of the participants were found to be risk-averse, and about one quarter each risk-averse and risk-seeking. Hence, risk-seeking behaviour could not fully explain the observed overinvestment.

⁷⁷ Accuracy of self-perceived absolute performance was found to be positively correlated with accuracy of self-perceived relative performance (significant at the 0.01 level, 2-tailed test).

With a confidence score for each subject, it is possible to study the predicted relationship between individual overconfidence and effort as well as project selection decisions (dependent variables).

Figure 5.12: Histogram of confidence levels in the experiment



Source: Own experimental data, analysis with SPSS

In order to test for a potential effect of individual overconfidence on the effort decisions observed in this experiment, I divided the sample into two groups according to whether a subject had chosen effort or not. These groups can now be compared based on their mean individual confidence scores. Under the null hypothesis (no effect of overconfidence), overconfidence should be randomly distributed so that the mean individual confidence level is about the same in each group. In contrast, the alternative hypothesis is derived from my model and predicts that there should be a difference in mean individual confidence, and that in particular, those subjects who chose effort should be more overconfident. The hypotheses to be investigated can thus be stated:

$$H_0 : \bar{a}_{effort} = \bar{a}_{no\ effort} \quad (no\ difference)$$

$$H_1 : \bar{a}_{effort} > \bar{a}_{no\ effort} \quad (greater\ overconfidence)$$

Since underconfidence is not covered by my model, all underconfident subjects were excluded from this analysis, so that the eventual comparison was carried out for a reduced sample of thirty-nine individuals.

The calculation of the mean individual confidence score reveals that there is indeed a difference between the groups; the effort-group has a mean of $\bar{a}_{effort} = 0.40$, which compares to that of the no-effort-group given by $\bar{a}_{no\ effort} = 0.32$. This finding is illustrated in the diagram on the left in Figure 5.13. Yet, even though consistent with the prediction of my model, this difference *does not* show up as statistically significant for an independent samples t-test (95% level of confidence, $t=-1.185$, $p=0.243$). Consequently, the null hypothesis cannot be rejected as the data fail to provide sufficient support for the alternative hypothesis.

The second decision for which observations were delivered by this experiment was the number of projects invested in by a subject. Under the assumptions of my model, the mean confidence score for those who chose to invest should be greater (indicating overconfidence) than for those who did not invest. Under the null hypothesis, confidence levels should not have affected decision behaviour and hence there should be no significant difference in the mean individual confidence scores for the two groups. As the analysis of the experimental data⁷⁸ reveals, mean overconfidence for subjects who did not invest (0.34) is slightly lower than that of subjects who chose one or more projects (0.39). Despite its tendency to support the model prediction for the effect of overconfidence on investment project selection, this difference fails to be statistically⁷⁹ significant, though.

However, there is also another way to analysing the role of overconfidence in project selection: In an alternative approach, I divided the sample into two groups based on their individual confidence scores and calculated the mean number of projects invested in $[\mu]$ per group. For splitting the sample, I simply chose the mid-point of the overconfidence range. If overconfidence had no effect on project selection, the mean number of projects invested in should be about the same for each group (null hypothesis); however, if the prediction of my model holds that overconfidence may

⁷⁸ Excluding underconfident subjects.

⁷⁹ The independent samples t-test yields a t-statistic of -0.235 at a 95% level of confidence ($p=0.815$).

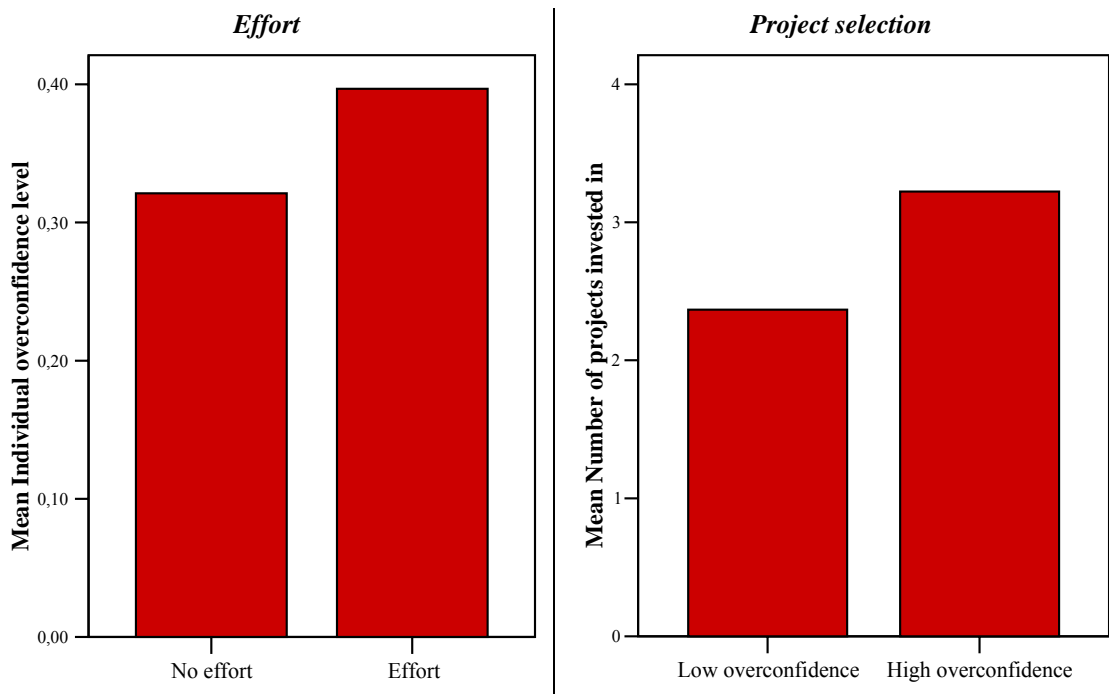
lead to overinvestment, the high-overconfidence group should have investment in more projects on average than the low-overconfidence group. Formally,

$$H_0 : \mu_{high} = \mu_{low} \quad (\text{no difference})$$

$$H_1 : \mu_{high} > \mu_{low} \quad (\text{overinvestment})$$

The difference in the mean number of projects invested is illustrated by the bar chart on the right in Figure 5.13. As this diagram shows, subjects of low to medium overconfidence invested on average in fewer (2.37) projects than subjects with stronger overconfidence (3.22). Furthermore, an independent samples T-test shows that this difference is statistically significant⁸⁰ ($p=0.015$) at a 95% level of confidence with a t-statistic of -2.55. Therefore, based on this analysis, the null hypothesis that there is no significant difference between the two groups regarding the mean number of projects invested in is rejected. In contrast, the experimental data regarding project selection with overconfidence seem to lend support to my model, and the notion that different confidence levels may be associated with different behaviour, namely the tendency to over-invest.

Figure 5.13: Association of overconfidence with effort and project selection



Source: Own experimental data, analysis with SPSS

⁸⁰ Assuming different variances (Levene's $p=0.000$).

By way of summary, the presented analysis of the experimental evidence on the role of overconfidence in project selection and individual effort level decisions has thus provided only partial formal support for my model in that project selection decisions were found to be associated with my measure of overconfidence. A further conclusion based on the tendency of the data to support also the model prediction regarding the effect of overconfidence on effort is not warranted, as the difference in confidence between the two groups is not statistically significant. I now turn to Experiment 2 as I present my findings on the role of regret aversion in project evaluation decisions in the following section.

5.3 Evidence from Experiment 2: Regret aversion in project evaluation decisions

The role of regret aversion in project evaluation was already considered earlier in this chapter using the survey data, but no significant variable relationship could be identified then. Given the limitations of ex-post measuring of regret by means of a survey questionnaire, it was felt that further empirical research on the impact of regret aversion on the project evaluation decision using a different approach might prove fruitful. Given the conditionality of regret upon the availability of a comparable alternative outcome, an experiment in which the independent variable could be controlled and isolated appeared to be ideal. A modified version of the experiment by Zeelenberg & Beattie (1996) as outlined in Chapter 4 was thus conducted to determine if regret aversion really had no impact on the project evaluation decision.

The experiment was conducted at the end of an undergraduate lecture in accounting and finance at the University of Bath's School of Management on 9 December 2005. Participation was voluntary and no participation incentive payments were made. However, to induce a motivation for optimal and sincere decision-making, it was announced that there would be prizes for five 'winners' in the form of telephone cards or book vouchers. A total of 57 students stayed on after the lecture to participate in the experiment. Of these, about half were female ($n_f = 27$). All subjects were enrolled in an economics or management related degree programme and were thus assumed to understand the concepts related to the decision task such as expected values.

The main experimental task required subjects to decide whether to continue or abandon a single investment project based on the information provided to them in the instruction handouts (Appendix C). The instructions manipulated the expected visibility of the alternative outcome such that the treatment group should anticipate regret for project abandonment (see Section 4.4.2 for details), and should hence have a relative preference for project continuation. However, under the null hypothesis, which assumes that the treatment (inducing regret aversion) has no effect, observed decision behaviour in terms of the ratio of projects continued to projects abandoned $[\phi]$ should *not* differ between the experimental groups. The two competing hypotheses can thus formally be stated as:

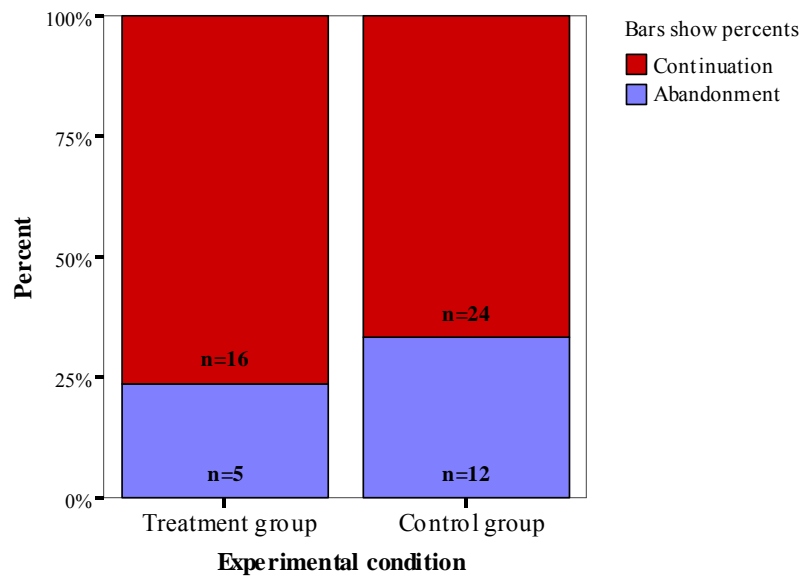
$$\begin{aligned} H_0 : \quad & \phi_{treatment} = \phi_{control} \quad (no\ difference) \\ H_1 : \quad & \phi_{treatment} > \phi_{control} \quad (more\ projects\ continued) \end{aligned}$$

Subjects were randomly⁸¹ assigned to one of the two experimental conditions⁸². The treatment group consisted of 21 subjects. Subjects choices were recorded and analysed using a 2 (conditions) x 2 (action choices) cross-tabulation. The table in Figure 5.14 shows that there is indeed a difference in behaviour between the two groups. Over three-quarters (76%) of the participants chose project continuation which is the riskier of the two options. This behaviour is consistent with the predicted effect of regret aversion because project continuation was the regret-minimizing, albeit not risk-minimizing, choice for the treatment group. However, a similar ratio of projects continued over projects abandoned was observed for the control group so that the overall picture does not seem to indicate a treatment effect. As a consequence, a general chi-square significance test fails to identify the deviation in behaviour of the treatment group as statistically significant.

⁸¹ The two different response sheets were distributed randomly among participants.

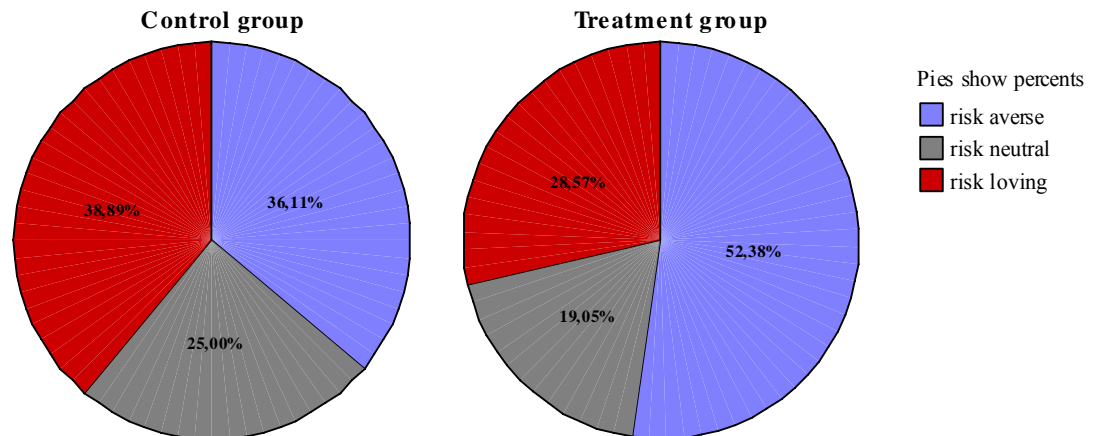
⁸² A final count showed that there were 36 subjects in the control group, and 21 in the treatment group.

Figure 5.14: Project evaluation choices in the experiment



Source: Own experimental data, analysis with SPSS

In order to gain a better understanding of what was driving subjects in the control group to choose the uncertain yet regret-minimizing option of project continuation to almost the same extent as the treatment group, I had analysed the two experimental groups with respect to individual risk preferences as proxied for in a simple gamble at the start of Experiment 2 (see Appendix F). Originally, I had assumed the risk preference type to be a random variable and thus equally distributed between the two groups. However, as the diagram in Figure 5.15 shows, this is not the case: In the control group, a total of 14 candidates (39%) were identified as risk-loving based on the initial risk-preference-type identification question; nine subjects (25%) were grouped as risk-neutral because they had shown no preference between a risky and a less risky gamble of identical expected values, and a further thirteen (36%) were classified as risk-averse. In contrast, there were only six (29%) out of the 21 candidates in the treatment group who could be judged as risk loving. Risk-neutrality was identified for four (19%), risk-aversion for eleven (52%) subjects in the treatment group.

Figure 5.15: Distribution of risk preference types within the experimental groups

Source: Own experimental data, analysis with SPSS

It can be seen from the pie charts in Figure 5.15 that even in the absence of any other factor, hence solely based on risk preferences, project continuation should be more favoured by the control group of Experiment 2 because it consists of surprisingly many risk-lovers; this should even more be the case for this experiment since the difference between the expected values used in the actual decision problem is relatively small. In contrast, the expectation for the treatment group regarding the project evaluation decision is more conservative given its higher proportion of risk-averse subjects. On the whole, thus, it is apparent that the two groups were not homogenous and any comparison of inter-group choice behaviour must account for risk preferences.

Yet even on the basis that there are about 40% of risk-seekers in the control group, the finding that two-thirds of the subjects in the control group chose the uncertain project continuation option is surprising⁸³. Hence, even though there was no treatment for the control group, behaviour inconsistent⁸⁴ with the risk-type was observed. Specifically, thirteen of twenty-two risk-averse or risk-neutral subjects in the control group chose continuation, compared to ten out of the fifteen in the treatment group. In relative terms, out of character risk-seeking behaviour was displayed by 59% of subjects in the control group, and by 67% in the treatment group. Arguably, a small treatment effect

⁸³ In fact, the difference between theoretical project evaluation choices based on risk preference types and actually observed continuation and abandonment decisions is statistically significant using Pearson's Chi Square ($p=0.018$).

⁸⁴ Assuming that individual risk types were determined accurately in the experiment.

might thus be stated; however, due to the large number of assumptions underlying such a conclusion, it will not be suggested here.

A possible explanation for the observed risk-preference 'switching', however, may be found within Prospect Theory (Kahneman et al., 1979), namely the proposition that an individual's utility curve is shaped like the letter 'S' because risk preferences are different in the domain for losses than in the domain of profits, so that the utility curve is convex for losses. Kahneman and Tversky found that whereas people typically display risk-averse behaviour for gambles with positive values, they seem to become risk loving when having to decide between a risky and a safe expected negative pay-off (Kahneman et al., 1979:279). Since the outcomes for the choice options in this experiment were mainly negative values, it is quite possible that the shift towards the uncertain option observed for the control group may be attributable to the concepts of Prospect Theory.

In conclusion, the experimental data presented in this section does not permit the rejection of the null hypothesis. Even though the behaviour of choosing the uncertain yet regret-minimizing continuation option predicted for the treatment group could be observed, the apparent heterogeneity of the two experimental groups with regard to risk preferences prohibits any test of difference in behaviour between the groups. Furthermore, the data analysis revealed the impact of some other factor that induced risk-seeking behaviour in both groups.

5.4 Summary

This chapter provided an overview of the empirical data collected in the survey and the two experiments, as well as my analysis of it. The data collection was aimed at delivering evidence by which answers to the following questions might be provided: Do overconfidence and regret aversion exist among practitioners who make capital investment decisions; can the behaviour predicted by the theoretical model be observed in reality; and does the empirical evidence support the hypothesized cause-effect relationships between the studied biases and the predicted / observed behaviour? The presented evidence has addressed these questions providing several interesting insights.

The survey resulted in evidence that seems to support the central assumption of this research, namely that those managers within companies who are responsible for

making capital investment decisions may be subject to the studied psychological biases of overconfidence and regret aversion. In addition, it appears that these managers make the very sort of sub-optimal decisions that are predicted by the model: Inefficient overinvestment, inefficient effort as well as late and premature project termination. Even though analyses of the association between the psychometric data (independent variables) and the observed decision behaviour in most cases did not permit a clear rejection of the respective null hypotheses, the findings were generally consistent with the predictions of my model. Similar results were obtained from the analysis of the experimental data. Although effort appeared to be associated with greater overconfidence, this relationship fell short of statistical relevance. However, a significant association between mean individual overconfidence and the number of projects accepted in Experiment 1 was found. Regarding the hypothesized effect of regret aversion to bias project evaluation decisions to be made in a regret-minimizing fashion could not be confirmed, even though the treatment group in Experiment 2 appeared to behave as predicted by the model.

Overall, the empirical evidence was thus largely consistent with the model, but was not sufficiently strong to abolish the traditional theory that overconfidence and regret aversion do not affect capital investment decisions. However, whilst the collected data may not allow making strong inferences about the proposed constructs and variable relationships, the 'circumstantial' evidence presented in this chapter should be sufficient to justify further empirical research into the role overconfidence and regret aversion in capital investment decision making.

CHAPTER 6: DISCUSSION AND OUTLOOK

Given the strong evidence in Psychology for the robustness and relevance of overconfidence and regret aversion in choice under uncertainty, yet the striking lack of recognition of these facts in corporate finance theory, my research sought to contribute to this apparent knowledge gap by advancing our understanding of how these studied biases may influence the capital investment decisions of individual managers. To this end, a formal model covering central choice problems of the investment decision process, namely investment selection (whether to accept or to reject a proposal), managerial effort and project evaluation (continuation / abandonment decision) was proposed. Overconfidence and regret aversion were integrated into this model in close adherence to the definition of the two biases in the literature, and predictions regarding their behavioural effects at the different decision steps were derived.

In order to confront my model and its predictions with empirical data, I furthermore designed and conducted a survey and two experiments. The survey questionnaire was made available by invitation to over 350 managers who were believed to be involved professionally in corporate capital investment decisions via the internet. The questionnaire was designed to record a respondent's choice preferences for different decision scenarios in addition to measuring individual confidence and regret aversion levels. Complementing the survey data, experiments of how overconfidence may affect individual project selection and effort choice, as well as how regret aversion may influence decisions in a project evaluation context were designed and carried out. The statistical analysis of the data revealed findings that are largely consistent with the model assumptions and predictions, even if they mostly do not pass the hurdle of statistical significance.

In the light of all of these findings, both theoretical and empirical, it is now possible to address the more general question regarding the relevance of this work in terms of its wider implications for practice and research. In this chapter, I thus begin by drawing attention to possible limitations of my findings. Bearing these in mind, I proceed with a discussion of the extent to which having overconfident or regret averse managers making capital investment decisions should be a concern to shareholders, and what might be done about this in terms of corporate governance. The chapter concludes with some suggestions for future research.

6.1 Limitations of the research and findings

Prior to discussing the relevance of the implications of the research in a wider context, it is important to outline the main limitations that may affect the predictions of the model and the interpretation of the empirical findings.

6.1.1 Limitations of the theoretical model

Any theoretical model must make simplifying assumptions, which result in limitations to the accuracy of the model predictions. Some of the assumptions I made in my model, like the risk-neutrality of the decision maker, were already discussed. Other assumptions should be made explicit at this point in light of the empirical data analysis and findings. In particular, I propose that the predictions of the model largely hinge on three factors.

First, much depends obviously on the ways in which overconfidence and regret aversion are modelled. The prediction that overconfidence in ability leads to an increase in managerial effort is based on the fact that overconfidence is modelled as an overestimation of the perceived impact of effort $[y]$ compared to the cost of effort. If modelled differently, for instance by arguing that since $[q_{oc} = q^{(1-a)}]$ it follows that $[p_{oc} = (y \cdot e)^{(1-a)} = y^{(1-a)} \cdot e^{(1-a)}]$, low to medium overconfidence would be predicted to be associated with higher, but at extreme levels with lower effort. Similarly, the behavioural effects predicted for the aversion to regret depend to a great extent on the fact that the disutility of regret is specified in this research according to the definition by Bell (1982). Assuming the actual pain of regret to be a fixed disutility independent of the value foregone would for example predict project continuation instead of project abandonment.

Second, in the model, the termination value was assumed to be known with certainty $[TV = L]$. It is, however, quite possible that this is not the case in reality. If an investment is abandoned, this will free resources, which would have been used for continuation, employable in a different venture such that new options for value creation are opened up. As a result, the value of the choice option 'abandonment' is in practice not always as certain as the model proposes. This in turn may lead to quite different behavioural predictions, particularly for regret aversion, and as a result, for the joint effect of two biases.

The third factor that has a significant impact on the predictions of the model is the use of the backward induction approach in solving the decision tree. It may be unreasonable to assume on the one hand that the decision maker has cognitive limitations and biases yet that he is also cognitively able (or willing) to conduct such lengthy analysis prior to making a decision. An alternative, more 'behavioural' modelling approach might thus consider each decision step in isolation, and in the order that the decisions are taken, to reflect the potential ad-hoc nature of managerial decision-making.

6.1.2 Limitations of the empirical data

The empirical data showed that managers can be prone to overconfidence as well as to regret aversion, and as a result, may make inefficient capital investment decisions; this analysis relied on measuring either bias in isolation, which is likely to deliver artificial results. The data also delivered some support for possible causal associations between the studied biases and the observed decision behaviour; although it was often not possible to reject the null hypothesis of no association between the variables. Overall, the findings are encouraging, as they appear to support the model predictions, and certainly support the notion that overconfidence and regret-aversion are pervasive among the target group. However, empirical findings should always be viewed with caution, as there are several ways in which their interpretation can be limited. For one, there are limitations arising from the choice of method, as discussed in Chapter 4. In addition, there are limitations that can only be pointed out once the data has been collected and analysed. Such limitations typically are due to specific circumstances of the conducted research.

Concerning the survey data, a fundamental limitation is the low number of completed responses. Several avenues as described previously were pursued to increase the response rate, but only with limited success; perhaps the inclusion, or at least the formulation, of some psychometric questions prevented stronger participation. Whatever the reasons, as a result of the low number of respondents, it is questionable whether the participating managers are representative of the population of capital investment decision makers. It could for instance be possible that only managers with certain psychological predispositions such as extraversion were willing to participate and respond to what may have been perceived as personal or even threatening questions. A further concern might relate to the findings on managerial optimism: It is

for instance reasonable to assume that any manager who might have thought that the prospects of his company were well below average (Q16) would already have left that company. As a result, the responses of managers still working at their companies – and thus being able to participate in the survey – should be skewed towards optimism⁸⁵. Moreover, as some respondents may not have considered each question in detail, the recorded choices would pertain to the target group, but would not be representative of how decisions are really made in practice. Although this is a problem of surveys in general, particularly when the respondents complete the questions themselves, its negative impact might be stronger for a small sample.

Concerning the experiments, an interpretation of the data may be limited because of the small number of observations, but also the limited performance incentives paid to participants. It is furthermore possible that the observed choices have alternative explanations and may not be driven by individual confidence or regret aversion. For instance, in the project selection experiment, it is imaginable that subjects perceived the task as a portfolio choice of allocating resources between a risky and a non-risky asset, such that decisions were made based on individual risk preferences. This argument would be consistent with the observation that there were many different levels of investment even though partial investment was a dominated strategy under all conditions. With regard to the project evaluation experiment, it must be noted again for the interpretation of the results that the experimental set-up was not identical to the choice problem analysed in the model. While it was made clear previously that this was an intentional and necessary aspect of the design of the experiment, the consequence is that the observation for that experiment may not directly relate to the model.

Finally, a limitation that was particularly manifest in the project evaluation experiment is caused by the potential interaction of other psychological influences. The theoretical model illustrated the possible interaction effects of overconfidence and regret aversion, and even though these interactions were not considered in the further empirical analysis, they may very well have played a role; moreover, since many more psychological biases may be relevant in any of the studied scenarios, there are numerous factors that may also affect behaviour. In experiments, however, the

⁸⁵ Arguably, however, this does not affect the validity of the observation that these individuals are overly optimistic.

simultaneous interference of such external factors is not necessarily a problem, and may even be desirable for better external validity, but only if the control and the treatment group are affected similarly by these factors. In the project evaluation experiment, it was discovered that subjects differed substantially in terms of risk preferences, but only because risk preference was measured. Yet the two groups may also have differed in many other aspects, which were not and cannot be entirely accounted for. The only way to minimize the effects from such 'noise factors' is by using large samples. As the samples in the research reported here were rather small, it is likely that there were other differences between the experimental groups besides the treatment condition that may affect the interpretation of the findings.

Despite these potentially limiting factors, I propose that my theoretical and empirical results provide a sufficient basis for reflection on the implications of overconfidence and regret aversion in a capital investment decision, and more generally, a corporate finance context. Prior to considering implications of my research, however, the next section makes a logical first step of evaluating the studied biases from a shareholder value perspective, based on my findings and existing related research from the literature.

6.2 Assessment of the role of overconfidence and regret aversion

The traditional view in finance theory assumes rational behaviour to describe optimal decision making in the pursuit of utility or value maximization. The presented research has placed a question mark on the descriptive accuracy of this view and proposed a framework of how two well-established drivers of human behaviour, overconfidence and regret aversion, affect managerial capital investment decisions. The model predictions regarding the effects of each of the two biases on the selection of an investment, managerial effort and the project evaluation decision are largely consistent with what the (limited) empirical research has discovered. Results from the survey and the experiments support the suggestion that managers who make corporate capital investment choices, which are quite important for a company's future profitability, are prone to overconfidence and regret aversion, and that these biases are likely to affect decision choices. In particular, the research has argued that overconfidence and regret aversion may individually cause managers to make a number of inefficient decisions, such as late abandonment of failing investment projects or overinvestment.

Since such behavioural effects represent deviations from normatively optimal choices, the interference of psychological biases is frequently seen as undesirable. In fact, traditional wisdom in our culture portrays the influences of human psychology as generally detrimental. There is for example Shakespeare's Romeo, who in an emotional overreaction decides to terminate his life upon receiving bad news about Juliet's well-being⁸⁶, or the overconfident Icaros who flew too close to the sun, so that the wax in his self-constructed wings melted, causing him to drown in the Mediterranean Sea. Unsurprisingly perhaps given this cultural endowment, Psychology has for a long time portrayed human biases as a deficiency of the brain. The term “irrational” was used to describe behaviour that was not consistent with the axioms of rational choice. In the words of Kuehberger (2002:439), individuals were considered “as the easy prey of a wealth of cognitive illusions”.

Avoiding an overly philosophical debate, the more relevant question to be asked here is how desirable overconfidence and regret aversion are in a corporate finance context. What are the potential costs associated with overconfidence and regret aversion, and if any what benefits of these two biases may there be? The following discussion reviews some of the arguments on the desirability of the studied biases as a logical step towards determining possible action implications for companies.

6.2.1 Potential costs of overconfidence and regret aversion

One result of my theoretical analysis is that overconfidence as well as regret aversion may lead to inefficient decisions. This proposition, to some extent backed by the empirical data, is also the conclusion of much of the existing literature in the field. Overconfident stock market investors tend to trade too much, leading to lower performance and lower profits (Barber et al., 2000; Biais et al., 2002). Systematic overestimation of the validity of private information due to overconfidence was found to explain patterns of over- and under-reaction in stock markets (Odean, 1998b; Daniel et al., 1998), a behaviour that should theoretically be ruinous to traders. George Soros is reported to having actively tried to fight feelings of overconfidence in order to remain successful (Pixley, 2002:48). In the paper by Roll (1983), managerial overconfidence is the reason why shareholders are made to overpay in corporate

⁸⁶ As the reader will recall, Juliet was not really dead initially. Hence, it might be argued that information asymmetries also contributed to Romeo's decision.

acquisitions. Brocas et al. (2004) find that entrepreneurs overconfidently forego free information. In Zacharakis et al. (2001), overconfidence causes venture capitalists to overestimate the probability of an investment being successful. In the model proposed by the present research, overconfidence is also found to promote decision behaviour that is not in the best interests of the shareholders. Given this non-exhaustive list, it seems fair to suggest that theoretical academic research generally argues that there may be large costs to managerial overconfidence.

This view, however, is not only taken by theorists. There is evidence that psychological biases are also perceived as detrimental to wealth by practitioners. Large international consultancies such as McKinsey & Company are cautioning their clients: “The twin problems of overconfidence and over-optimism can have dangerous consequences when it comes to developing strategies” (Roxburgh, 2003:29). The perhaps most spectacular example of just how fatal such consequences can be is the collapse of Barings, the merchant bank, in 1995: Apparently, unfounded optimism about the market performance, and a feeling of knowing better than all the others were important factors in this bankruptcy. In his detailed analysis of the case, Paul Stonham (1996b) notes

“[Leeson’s] bullish view [on the Nikkei Index] was curious in the light of the current macroeconomic position of Japan [...]. Also, the attitude of the markets was almost entirely the opposite...” (Stonham, 1996b:270).

Regarding the aversion to regret, Shefrin et al. (1985) proposes that the disposition effect observable with stock market traders may be partly attributed to this bias. This effect is then adapted to a corporate finance context by Statman et al. (1987) who argue that regret aversion is a cause of sub-optimal continuation of failing corporate investments. More recently, Fisher et al. (2003) find that regret aversion may cause managers to constantly shift between different hedging strategies, thinking that the other strategy might have been better. Due to associated transaction costs, regret aversion should therefore also destroy some shareholder value in that model. Overall, alongside other biases, regret aversion is clearly perceived to be generally undesirable from a shareholder value point of view. This dominant negative view of psychological biases in financial decisions is reflected in Shefrin (2002:2) defining "behavioural costs" as "the loss in value associated with errors that managers make because of cognitive imperfections and emotional influences".

6.2.2 Potential benefits of overconfidence and regret aversion

In contrast to most of the literature, which argues that overconfidence and regret aversion should best be eliminated, there are, circumstances under which the two biases may be of avail. In fact, overconfidence⁸⁷ and regret aversion can be argued to have certain benefits at each of the three stages of the capital investment decision process.

The prediction of my model for overconfidence in project selection was that it will lead to the overestimation of the value of an investment. In my model, this bias was potentially inefficient because the manager was assumed to have preferences identical to shareholders. However, with a variation to this assumption, this conclusion could change. This idea is modelled by Gervais et al. (2003): Assuming a risk-averse manager acting on behalf of well-diversified and thus risk-neutral shareholders, the authors show in a formal model how managerial overconfidence may be useful in aligning⁸⁸ these different risk preferences. Gervais et al. (2003) suggest that in such a scenario, “moderately overconfident managers make decisions that are in the better interest of well-diversified shareholders than do rational managers” (Gervais et al., 2003:2). In the model by Gervais et al. (2003), the moderately overconfident manager accepts projects more quickly, which can be valuable if a good project would otherwise expire or be lost in the case of a rational but more hesitant decision maker (p.13). A similar argument could also be made for regret aversion.

Concerning the effort level choice, the model presented in this thesis suggested that both overconfidence and regret aversion lead to greater effort. Effort beyond the optimal level was deemed to be excessive because the proposed model assumed that shareholders are directly affected by the cost of managerial effort. Yet it is also conceivable that the cost of effort only reduces the manager's utility or pay-off, if the decision is modelled in a principal-agent framework. If the cost of effort does not reduce shareholder value, the level of effort that is optimal from the shareholders' perspective will be greater than what the (unbiased) manager would view as optimal. Consequently, if overconfidence makes the manager work harder, the bias can have a

⁸⁷ For review of why self-confidence is valuable, generally and in an economic context, see Bénabou & Tirole (2001)

⁸⁸ Overconfidence is seen as potentially beneficial due to its risk-shifting property by Kahnemann et al. (2000).

positive value effect by counteracting any moral hazard costs. This point is formally made in a recent paper by Richard Fairchild. Analysing the capital structure decision, Fairchild (2005) shows that overconfidence may entice the manager to choose excessive leverage. Despite the associated increased default risk, the expected financial distress costs may be offset by the positive effect on firm value⁸⁹ of the overconfident manager's extra effort (Fairchild, 2005:15).

Finally, overconfidence and regret aversion may also be beneficial at the project evaluation stage. In the model presented here, overconfidence may bring about sub-optimal continuation of a failing investment. Yet even if the rationally expected continuation value is lower than the termination value, and the objective probability of success is minimal, it is still possible that the investment may be turned around against all odds. To illustrate this potential positive effect of overconfidence, Kahneman & Tversky (2000) invoke the analogy of competitive sports, where leaving the field prematurely in the face of difficulty is not a viable option, such that "the hope of victory increases effort, commitment, and persistence in the face of difficulty or a threat of failure, and thereby raises the chances of success" (p.477). In contrast, the aversion to regret was predicted to result in overly cautious behaviour and premature termination of investments.

Given that there are not only costs but also latent benefits to managerial overconfidence and regret aversion, a condemnation of these biases can only be made under certain restrictions. A final conclusion on the net effect of overconfidence and regret aversion shall thus remain a challenge for future research. However, in terms of a preliminary judgment, and in the light of present knowledge the model predictions, it would appear that there are more downsides than upsides to having an overconfident or regret-averse manager. This view is also endorsed by researchers who have been at the forefront of studying these decision biases for years. For example, Griffin et al. (1992:432) "doubt that that the benefits of overconfidence outweigh its costs". In the next section, I therefore present different ways in which corporate governance policy might attend to these concerns.

⁸⁹ Another interesting feature of this model is that even though shareholder value may increase due to managerial overconfidence, overall welfare may be lower as creditors are worse off due to the increased default risk.

6.3 Corporate governance implications

In the past, corporate governance suggestions such as those of the 'Combined Code' of the year 2003 were mainly concerned with the alignment of interests of managers with those of shareholders (Rayton & Cheng, 2004:5). In light of the findings on the role of managerial biases like overconfidence and regret aversion, it might be useful to pay explicit attention to such non-rational drivers of behaviour, too. The model presented here intentionally abstracted from the effects of a misalignment of interests; yet on the basis of the insights offered on the two studied biases, it would seem that common incentive systems as proposed for the alignment of interests in the principal-agent literature are not likely to be an appropriate way of addressing the identified behavioural biases. Although the role of psychological biases in economic decisions is considerably under-researched, the literature offers several recommendations on how to correct for individual overconfidence and regret aversion. With overconfidence having received more attention, some of the 'remedies' were made with reference to this bias only; other suggestions, however, are more general and may thus apply to both overconfidence and regret aversion. The different propositions are presented next.

6.3.1 How to remedy psychological biases

With respect to overconfidence alone, two approaches for correction, each targeting a different possible source of overconfidence, can be distinguished. Blanton, Pelham et al. (2001) assume that overconfidence is caused by the motivation to protect self-esteem that prevents an individual from admitting to himself the limits of his knowledge. The authors suggest that overconfidence may thus be reduced by boosting feelings of self-worth in some other domain, or by reducing the risks at stake in the decision task (dissonance reduction, Blanton et al., 2001:383). In practice, this may imply creating a corporate culture where an error is not punished harshly but viewed as a lesson that increases experience and human capital of the decision maker.

In contrast to this motivational perspective, Griffin et al. (1992) argue that overconfidence originates from cognitive processes, in particular from the tendency of individuals to evaluate arguments for and against a given hypothesis by giving too little regard to the weight of these arguments. Consequently, one way to reduce overconfidence, termed counter-argumentation, is to require managers to think of reasons challenging their favoured choice option (Russo et al., 1992). Based on

evidence that overconfidence may be reduced with experience through learning, Russo et al. (1992) furthermore propose that receiving feedback faster and more often could help biased managers.

Concerning psychological biases more generally, including regret aversion and overconfidence, three broad strategies for corrective action are distinguished. Of these, the one most frequently mentioned in the literature is creating awareness among decision makers of the existence and likely effects of psychological biases. Fenton-O'Creevy et al. (2003) and Neale & Bazerman (1985:46) suggest formal training for key employees to that effect. Russo et al. (1992) propose that if managers knew more about how their minds work, this would already be an important and perhaps even sufficient step as it would allow managers to come up with their own techniques to control their decisions.

One such technique, recommended by Ricciardi & Simon (2000), is for managers to keep a written record of what motivated their decision. This record could then help them become aware of potential non-rational influences on their decisions. In this spirit, as argued by Zacharakis et al. (2001:18), it might also be helpful to quantify any decision as much as possible. In this context, sophisticated appraisal methods such as the net present value method, which requires detailed forecasts, might be of value. On the other hand, it could also be argued that quantification leads to a false sense of control, thereby fostering overconfidence.

It has also been suggested that delegating important decisions to groups may reduce the impact of cognitive biases (Russo et al., 1992). In fact, some⁹⁰ organisations have set up so-called investment committees. Yet research on stock market investment clubs in the US reveals that the majority of them underperformed compared to the benchmark index (Odean et al., 2000), thus one may ask if investment decisions are indeed better when taken by groups. An interesting paper by Payne & Wood (2002) deals with this question. A central finding of their research is that nearly two-thirds of surveyed investment committee members believe that groups are better at making good decisions (Payne et al., 2002:96). However, regarding the project evaluation decision, research is cited which showed that commitment to a failing project does not decrease but increase in groups (p.97).

⁹⁰ Examples of Finance and Investment committees are Roche, the Swiss global pharmaceutical and diagnostics company, (http://www.roche.com/de/home/company/com_gov/com_gov_com.htm) and Transport for London (http://www.tfl.gov.uk/tfl/pensions/investment_committee.asp).

Payne et al. (2002) therefore challenge the ability of groups to reduce psychological biases:

“...do not count on groups to correct for systematic bias. If you want to correct for systematic bias, my suggestion is to concentrate on training individuals [...] If you try to wait for the group to correct judgment bias, that’s not going to happen” (p.101).

According to Payne et al. (2002:95), an important reason for the existence of groups is that in the case of a bad decision, there is not just one single individual who will be blamed. Arguably, though, this should reduce anticipated regret.

A further strategy to make decisions that are more rational consists in somehow inducing an automatism for the actual decision in order to make it more objective. Ricciardi et al. (2000) propose setting in advance fixed criteria by which abandonment decisions are made. However, my models did already assume such external decision rules based on the expected net present values of the choice options. This did nothing to align decisions under regret aversion or overconfidence with optimal decision behaviour, though, because the cognitive biases affected the valuation of the decision options.

A more effective solution to introduce the desired objectiveness may be to delegate important decisions. Statman et al. (1987), who consider the effect of regret aversion together with framing on project termination decisions, recommend that companies set formal frameworks such that evaluation decisions are not taken by the project manager but by someone more neutral instead (p.12). This is where Statman et al. (1987) see a key role for finance managers – as long as they are otherwise disengaged⁹¹ from the investment project – and for external consultants (p.13). This idea of division of responsibility can also be found in Russo et al.’s (1992) proposal to distinguish between project management action, where biases are more likely to be beneficial, and decision making, which should best be done free of biases.

When the project selection decision is not taken by the same person who developed the forecasts and championed the investment, the forecaster's biases could be left unchanged so long as the decision maker is made aware of these biases and can adjust forecasts for the purpose of his decision accordingly. This strategy is recommended in

⁹¹ It should be noted, however, that my research largely targeted finance managers and still found evidence of overconfidence, regret aversion as well as inefficient investment decision making.

the Green Book⁹² for UK government offices' capital budgeting. The UK Treasury alerts the different government offices of a "demonstrated systematic tendency for project appraisers to be overly optimistic" in formulating forecasts for investment projects. To address that problem, the responsible project appraisers are advised to make "explicit, empirically based adjustments to the estimates of a project's costs, benefits, and duration" (Green Book, H.M. Treasury, 2003, Annexe 4: 1).

Such an adjustment might even be based on a measurement of the individual degree to which an individual is prone to different biases identified as relevant. Fenton-O'Creevy et al. (2003:65) proposes to implement psychometric measures to collect such information already at the recruitment stage. An eventual weakness of any such downward adjustment, though, is that it could lead to project champions intentionally making an upward adjustment in any forecasts they submit so as to ensure that an eventual discount would still see the investment, of which they are absolutely convinced that it is worth undertaking, accepted.

The presented approaches to correcting for psychological biases in capital investment decisions were made based on the understanding that each of them may lead to sub-optimal decisions. Assuming biases in isolation is not very realistic, though, and hence of limited use in formulating real corporate governance policy. My model has demonstrated, that if combined, overconfidence and regret aversion can be useful as they are offsetting in some cases. From this insight also emerges a potential for application of the presented model in controlling for certain undesirable behavioural effects of a given bias. For instance, extreme overconfidence may be restrained by creating conditions for decision making under which regret aversion is strengthened. There are also implications for the management of human resources in that it may be useful to assess employees' psychological predispositions towards certain biases, and to take individualized action by promoting the respective opposite drivers of behaviour. However, given the existence and interaction of a range of psychological biases in addition to overconfidence and regret aversion, the question arises as to what implications correction might have. Specifically, as any such correction of psychological biases can only be partial and thus imperfect given our limited understanding of the psychological drivers of human decision making under uncertainty, would it not perhaps be better not to interfere?

⁹² H.M. Treasury, The Green Book (2003), Annexe 4, p.1.

6.3.2 Should individual psychological biases be corrected for?

In practice, there are a large number of factors affecting decisions under uncertainty that no theory can fully capture. Even if there were certainty that the existence of one or more psychological biases is undesirable, and given the possibility to eliminate these biases, it would still be difficult to know exactly what effects such partially unbiased behaviour might have; and even if behaviour could be 'freed' of all biases to leave a perfectly rational decision maker, there can still be no guarantee that this would lead to the optimal outcome. 'There is nothing as disastrous as a rational investment policy in an irrational world' is a quote commonly attributed to John Maynard Keynes that nicely summarizes this argument. An example of a situation where rational behaviour will inevitably fail to achieve the optimal outcome is the famous Prisoner's Dilemma, as Camerer (1997) points out. In this game, there are two alternative course of action to choose for each of the two players, 'defect' and 'cooperate'. Individual pay-offs vary as a function of the combined strategies. Yet, as neither player can observe the choice of the other, there is uncertainty about the final pay-off. The rational, self-interested solution to this game is to defect for each player, yet the obtained equilibrium is not Pareto-optimal. Both players would be better off if they cooperated.

A central insight to be considered in devising methods to correct for biases is hence that neither regret aversion, nor overconfidence, nor any other bias for that matter, is likely to influence decisions in isolation. Hence, even if for overconfidence alone the advantages do not make up for the costs as Griffin et al. (1992) claim, in a larger picture of several psychological processes interacting, one specific bias may have an important role by controlling another bias. For example, Besharov (2002) proposes a theoretical model in which overconfidence and regret aversion offset the effect of hyperbolic discounting. Hyperbolic-discounting (Akerlof, 1991) describes the finding that human discounting of future costs and benefits is time-inconsistent (not constant over time). As a result, individuals value future, discounted gains less than equal-size present gains (Besharov, 2002:6). In Besharov's model, hyperbolic discounting leads to sub-optimally low effort, but this is offset⁹³ by the effort-increasing effects of

⁹³ As Besharov also notes, the analysis of the opposing behavioural effects does *not* imply that the different biases exist *because* they counteract each other (p.5).

overconfidence and regret aversion (p.10). Besharov (2002:14) thus cautions that reducing just one bias may have "ambiguous welfare properties".

Implicit in these arguments is the view of psychological biases as a system of checks and balances that may be rather useful and efficient in dealing with the anomalies of life outside the world of econometric models. There seems thus to be link to Gigerenzer & Selten's (2001) 'adaptive toolbox' of mental heuristics as far as the larger view of the role of human psychology in decision making under uncertainty is concerned. However, in the case of capital investment decisions, it would appear that in reality the different biases might not always balance out, as there are many instances of sub-optimal decision making which are consistent with some of the predictions of the model proposed here. Although elimination of certain biases like overconfidence or regret aversion may be a double-edged sword, it is argued here that ignoring the role of psychological biases in capital investment decisions and a complete laissez-faire approach are not the ideal recipe either.

In identifying the optimal strategy for addressing the potential costs associated with capital investment decisions that are driven by overconfidence or regret aversion, one should not ignore the possibility that practitioners are ahead of academics and already have relevant systems in place. Surveys like the one conducted for this research typically observe that managers rely on a range of theoretically flawed decision rules for project selection such as the payback method. It has been proposed that this behaviour may be explainable as a means of reducing moral hazard problems (Berkovitch & Israel, 1998; Marino et al., 2005:320). However, it may also be the case that managers prefer unsophisticated appraisal methods because they require fewer forecasts than the net present value technique, and are therefore less exposed to any uncertainty-induced bias.

This section has tried to show that the theoretical and empirical contribution to knowledge of the presented research should be relevant to practitioners and be considered in the development of corporate governance policies. Given the considerable gaps in the body of theory relating to the precise workings and interactions of the many psychological phenomena that exist alongside overconfidence and regret aversion, and how these might affect capital investment decisions, the presented research should in particular be seen as a pioneering effort highlighting the need for academics to further advance understanding in this field. Some potential avenues for such future research are offered in the next section.

6.4 Suggestions for future research

Given that the presented research is fairly novel and adds to a field of research that is largely unexplored, there are many highly interesting directions that future research could pursue. Behavioural corporate finance is one of the most rapidly developing and exciting fields in Finance as the impact of psychological biases and emotions on economic decision-making is only beginning to be viewed as the norm rather than the exception. Given their importance and shared features with stock investments, the decisions related to corporate capital expenditure offer a great potential for future research. At a first level, it may thus be worthwhile to extend the research reported here. This may be done in a number of ways.

With respect to the theoretical model, one possible extension would be to introduce a second strategic player in the form of shareholders. The analysis could then take into consideration potential information asymmetries, in the spirit of Richard Fairchild's (2005) capital structure model. Additionally, an inter-temporal dimension could be added to my model to make it more dynamic. This could also entail a discussion of how accurately individuals are able to forecast future emotions, since there is evidence that, related to the concept of hyperbolic discounting, people display a present-oriented bias (O'Donoghue & Rabin, 1999). As a result, future regret may seem less painful than current regret so that regret aversion would tend to favour project continuation instead of abandonment. In addition, given the insights from the questionnaire on situationally different intensities of regret aversion, improved predictions may be obtained by assuming different parameters of individual regret aversion depending on whether the particular decision option represents 'inaction' or 'action'.

Regarding the experimental data collection, it would perhaps be interesting to replicate the experiments on a larger scale (more subjects, higher financial incentives) which may render some of the observations more significant, and allow for stronger testing of the model. In order to untangle the effect of regret aversion from the possible influence of inconsistent risk preferences over losses in Experiment 2, it may be preferable for the experimental outcomes of the project evaluation decision problem to remain in the positive domain. In addition, an alternative experimental design to investigate regret aversion might be employed; Appendix F contains an outline. Very exciting possibilities for studying the influence of the human brain in an economic setting also arise from the use of magnet resonance imaging in recent research in the relatively young field of neuro-economics (e.g. Kenning & Plassmann, 2005).

As for the field data, managerial overconfidence may be better assessed using the presented measures in a survey that is *not* anonymous. Alternatively, Malmendier & Tate (2005) propose a new methodology for determining if a CEO is overconfident involving newspaper reports and corporate publications. The ultimate challenge would then consist of being able to attribute managerial confidence levels to specific companies, and to analyse firm level data on investment decisions, but also on other corporate finance problems jointly with the overconfidence data. With respect to regret aversion, the key issues to be resolved are developing a more sophisticated way of measuring the extent to which individuals are concerned by regret, and gaining a better understanding of which outcomes lead to the greatest regret. With stronger and more significant data than could be obtained for the reported research, an analysis of the joint effect of overconfidence and regret aversion with behaviour may also prove to be valuable. Finally, it would furthermore be interesting to consider whether individual overconfidence and regret aversion are indeed independent of each other, or if there is some link between these, and potentially other, psychological biases. Future research on human cognition might thus wish to further explore the interdependence of biases, as well as the related potential existence of certain 'personality types' with regard to phenomena such as overconfidence and regret aversion.

6.5 Summary

In this final chapter, the research was considered from an ex-post, disengaged perspective. First, some of the more important limitations of the model and the empirical data were outlined. With changes to some assumptions such as ex-post outcome observability or the interpretation of overconfidence and regret aversion, the model could lead to different predictions. Although the derived propositions somewhat tend to be supported by the survey and experimental data, a significant limitation of the empirical results is that they are mostly not statistically significant and thus do not qualify for formally assessing the model. However, evidence of overconfidence was found across the different methods used, and there are some indications that these biases do affect decision-making. On the basis of this result, the benefits and costs of overconfidence and regret aversion based on the conducted research and relevant other research was discussed and it was concluded that, at least in a capital investment decision scenario, these biases appear to be detrimental to shareholder value. It is thus

reasonable for shareholders to consider controlling for overconfidence and regret aversion in a corporate governance context, and several approaches of how this might be done were pointed out. On the other hand, given potential interaction effects of psychological biases and the fact that they may most of the time do a good job dealing with the imperfections of reality, even for investment decisions it remains questionable how to address phenomena like managerial overconfidence and regret aversion without ending up with an even worse result. In view of these uncertainties on the part of academics due to deficient knowledge, and the relevance of the topic to practitioners, the chapter closed with a call and some suggestions for future research.

CONCLUSION

Capital investments are of fundamental importance in the value creation process of companies. In order to maximize shareholder value, managers should only accept investments that have a positive NPV, allocate the optimal account of resources by trading off associated benefits and costs, and terminate any investment for which the continuation value is exceeded by what could be obtained with immediate abandonment. Yet due to fundamental uncertainty, these decisions need to be made based on forecasts and expectations. Research in psychology has shown that under such conditions, the information processing of the human mind, and thus decision behaviour, can be affected by a range of biases arising for cognitive, emotional or motivational reasons. Two of the most robust biases are overconfidence and the aversion to regret.

Overconfident individuals systematically overestimate their chances of success because they believe they know better, have better ability, and feel in control. The phenomenon of regret aversion describes the tendency of people to imagine prior to taking a decision what possible regret they might feel for each possible outcome, and then to make their decision in order to minimize regret. In the presented research, these two biases were formally integrated into a model of the capital investment decision process, consisting of project selection, managerial effort, and project evaluation. Solving this model by backward induction revealed systematic deviations from normatively optimal behaviour at all three studied decision steps. Specifically, the model predicted that overconfidence and regret aversion might lead to over-investment and excess effort; further, while overconfidence was shown to potentially cause sub-optimal project continuation, regret aversion may lead to premature abandonment of an investment.

The survey of managers from the largest UK public companies exposed widespread overconfidence as well as regret aversion, with individual differences in both biases. In addition, these managers were found to commit the very decision errors predicted by the model. The inferential statistical analysis delivered indicative evidence of the hypothesized relationships between the psychological biases and the reported choice behaviour, which largely failed to be statistically significant, however. To complement these observations, two experiments were conducted. The first experiment showed that overconfidence was positively associated with the amount invested, while the observed

excess effort could not clearly be attributed to either experimental condition. In the second experiment, inducing regret aversion resulted in the predicted effect but due to considerable differences in risk-preferences between the experimental groups and a limited sample, no significant effect could be found.

Despite some limitations to the interpretation of the model predictions and the findings, and on the basis of having observed both, overconfidence and regret aversion, as well as the predicted behaviour, and limited empirical support for the predicted association between these variables, the final chapter discussed the implications of the work. A discussion of the benefits and costs of the studied biases concludes that they are indeed likely to be detrimental to shareholder value on average. However, the presented implications for corporate governance policy must be applied with care, as the complexity of the subject does not permit predictions about the effects of partial control of psychological biases. Given this limited understanding, yet the considerable importance of the topic, further research in both Psychology and Finance has a great potential to provide valuable new insights.

The presented research contributes to the existing body of literature in Behavioural Corporate Finance in several ways. For one, very little work only has so far been conducted on the effects of the psychological biases of managers on corporate finance decisions. None of this research has looked formally at the interaction effects of overconfidence and regret aversion in the presented corporate capital investment decisions context. Finally, my research also contributes to the existing literature by suggesting practical ways in which the role of the two studied phenomena can be empirically investigated.

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APPENDIX A: PROJECT EVALUATION WITH REGRET AND TOTAL OUTCOME OBSERVABILITY

In this case, it is assumed that the manager can observe the state of nature realization even if he chose abandonment in addition to knowing the termination value with certainty under either strategy. Consequently, each strategy is associated with potential regret (Figure A1). Consistent with my definition of regret, which was adopted from Bell (1982), the regret anticipated for continuation and subsequent realization of the bad state of nature is given by

$$(1) \quad R_{ct} = CV_l - L$$

In the alternative case, when the investment is abandoned, the decision maker will experience regret if it turns out that continuation would have been better, thus

$$(2) \quad R_{ab} = L - CV_h$$

Figure A1: Anticipated regret in project evaluation (total observability)

		<i>Chosen strategy</i>	
		<u>Continuation</u>	<u>Abandonment</u>
<i>State of nature</i>	<i>Good</i>	No regret; CV_h realized	Regret = R_{ab}
	<i>Bad</i>	Regret = R_{ct}	No regret; $L > CV_l$ realized

Assuming zero overconfidence [$b = 0$], the continuation value for a given level of managerial regret aversion [r] is hence

$$(3) \quad CV_{ra} = q \cdot CV_h + (1 - q) \cdot (CV_l + r \cdot R_{ct}).$$

Due to uncertainty about the continuation value, the abandonment option is also associated with potential regret, so that the expected value of terminating the investment can be stated as

$$(4) \quad TV_{ra} = q \cdot (L + r \cdot R_{ab}) + (1 - q) \cdot L \quad \text{(total outcome observability)}$$

Note that regret in abandonment occurs with probability [q] because it is associated with the good state occurring, and having failed to continue the investment.

The regret-averse manager will consequently abandon an investment if $TV_{ra} > CV_{ra}$:

$$\begin{aligned}
 qL + qrR_{ab} + (1-q) \cdot L &> qCV_h + (1-q) \cdot CV_l + (1-q) \cdot rR_{ct}; \\
 L + qr(L - CV_h) &> q \cdot (CV_h - CV_l) + CV_l + (1-q) \cdot r \cdot (CV_l - L); \\
 L + qrL - qrCV_h &> q \cdot (CV_h - CV_l) + CV_l + rCV_l - rL - qrCV_l + qrL; \\
 L + rL - CV_l - rCV_l &> q \cdot (CV_h - CV_l) + qrCV_h - qrCV_l; \\
 (1+r) \cdot L - (1+r) \cdot CV_l &> q \cdot (CV_h - CV_l) + qr \cdot (CV_h - CV_l); \\
 (1+r) \cdot (L - CV_l) &> (1+r) \cdot q \cdot (CV_h - CV_l); \\
 L &> q \cdot (CV_h - CV_l) + CV_l
 \end{aligned}$$

As can be seen in the last line of this transformation, the decision rule for a regret averse but otherwise unbiased manager in the project evaluation decision assuming total outcome observability is identical to the normatively optimal decision rule.

APPENDIX B: FORMAL PROOF FOR EQUATION 3.15

Identifying the critical level of overconfidence [b'] for a given level of managerial regret aversion [r] for which the effects of the two biases exactly offset by equating (Eq-3.14) and (Eq-3.15) such that $CV(b = b'; r) = CV_u$:

$$(Eq-3.14) \quad CV = q^{(1-b)} CV_h + (1 - q^{(1-b)}) \cdot (CV_l + rR_{ct}) .$$

$$(Eq-3.15) \quad CV_u = qCV_h + (1 - q)CV_l .$$

$$\begin{aligned} qCV_h + (1 - q)CV_l &= q^{(1-b')} CV_h + (1 - q^{(1-b')}) \cdot (CV_l + rR_{ct}); \\ q(CV_h - CV_l) + CV_l &= q^{(1-b')} (CV_h - CV_l - rR_{ct}) + CV_l + rR_{ct}; \\ q^{(1-b')} &= \frac{q(CV_h - CV_l) - rR_{ct}}{(CV_h - CV_l - rR_{ct})}; \end{aligned}$$

Since $\log_b x = n \leftrightarrow b^n = x$,

$$\log_q \left[\frac{q(CV_h - CV_l) - rR_{ct}}{(CV_h - CV_l - rR_{ct})} \right] = 1 - b';$$

and hence

$$(Eq-3.16) \quad b' = 1 - \log_q \left[\frac{q(CV_h - CV_l) - rR_{ct}}{(CV_h - CV_l - rR_{ct})} \right] .$$

APPENDIX C: CREATION AND LAUNCHING OF THE INTERNET BASED QUESTIONNAIRE

Once the type of questions and their order was determined, the questionnaire was placed on the internet. Compared to a physical questionnaire, the overall cost was thus significantly lower due to savings on printing, and on postage for the return envelopes. There are different possibilities of how such an online questionnaire can be created. Following an analysis of the various costs and benefits involved, I decided to employ the services of a company specialised in the hosting of surveys. The associated fees were outweighed by the reliability of the web site in terms of availability, as well as the greater efficiency in administration of the questionnaire.

In addition, by providing a basic toolbox for the development of the questionnaire, the web site was very convenient. Although all questions had to be entered manually, it was possible to choose between different standard types of questions (open or closed, multiple choice or rating scale) for which then a mask with all required entry fields opened. At the same time, a coding could be assigned to the responses. Furthermore, it was possible to define ‘compulsory’ questions that had to be answered in order to be able to submit the questionnaire. Although this could arguably reduce participation numbers when compared to a pen-and-paper survey, it would also ensure that only fully completed questionnaires were received. Once the questionnaire was saved and launched, it was available via a unique internet address that could be linked to from any other web site.

Initially, I placed the link to the survey on my personal homepage on the University’s server. Yet following the pilot survey, it was felt that a more ‘professional’ appearance could be beneficial for the response rate. In response, I set up the site www.investment-decisions-survey.net as a dedicated point of entry to the questionnaire. This first page was designed to reassure participants of the authenticity of the survey and contained my contact information and the logo of the School of Management (Figure F1).

Figure C1: Online survey starting page



The screenshot shows the starting page of the 'Real capital investment decisions survey'. At the top left is the URL 'www.invest-decisions-survey.net'. At the top right is the University of Bath School of Management logo. The title 'Real capital investment decisions survey' is centered. Below it, text states the survey is part of research at the University of Bath, led by Mr C. Klauss. A contact email 'comments@invest-decisions-survey.net' is provided. A blue link 'Please click here to continue' is at the bottom.

www.invest-decisions-survey.net



Real capital investment decisions survey

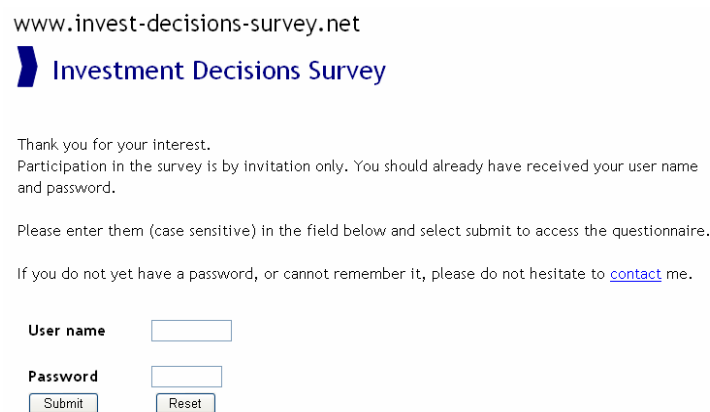
This survey is part of the research in Finance undertaken at the University of Bath.

Responsible for this survey is Mr C. Klauss, School of Management, University of Bath.
Contact via E-mail: comments@invest-decisions-survey.net

[Please click here to continue](#)


By clicking on a link to continue participants then reached a page where they were required to enter a password and username to access the questionnaire (Figure F2). The log-in information had been provided in the invitation letters, and was the same for the entire sample. The sole purpose of this secured access was to control who could respond and thus avoid uninvited responses that might lower the quality of the data.

Figure C2: Online survey password access page



The screenshot shows the password access page. It includes the URL 'www.invest-decisions-survey.net' and the title 'Investment Decisions Survey'. Text explains that participation is by invitation only and that users should have received their login details. It instructs users to enter their username and password (case sensitive) and click 'Submit'. A 'Reset' button is also present. A link to 'contact' is provided for users who do not have a password.

www.invest-decisions-survey.net



Thank you for your interest.
Participation in the survey is by invitation only. You should already have received your user name and password.

Please enter them (case sensitive) in the field below and select submit to access the questionnaire.

If you do not yet have a password, or cannot remember it, please do not hesitate to [contact](#) me.

User name

Password

Upon posting the correct log-in data, participants were given some brief instructions as to the aims of the survey on a page that contained a button to start the questionnaire at the bottom of the page (Figure F3). Each participant who clicked on that button was counted by survey hosting company as a visitor to the questionnaire. This value compares to the number of questionnaires submitted to show how many participants had shown initial interest in the survey but had eventually decided not to submit any responses. A further advantage of using the professional hosting service provider was

that responses to the questionnaires would be saved reliably and were then available for download in a MS Excel or an SPSS data file format. Not only was this convenient, but it also eliminated the possibility for errors that could arise when manually transferring the data from the questionnaire to the computer.

Figure C3: Online survey – Instructions page

Questionnaire: Introductory comments

Thank you for participating!

Your password was correct. Prior to starting the questionnaire, please note the following points that will help you in responding:

The aims of this questionnaire

- Explore how individual managers make investment decisions
- Explore why certain decisions are made the way they are made

What is meant by 'investment project'?

- A medium-sized project, i.e. not a relatively small purchase, and not a large transaction like an acquisition
- **An investment for which you would use financial appraisal rules**
- The investment must involve **uncertainty** (timing and value of cash flows)

Confidentiality

- Please be assured that your responses to the following questions will be treated with the strictest **anonymity**
- At no point will the identity of participants in the survey, or that of their employers, be revealed

Please click here to start the questionnaire

APPENDIX D: THE QUESTIONNAIRE

Capital Budgeting Decisions		Page 1/3	0%
A - Demographic information			
1.	Gender *		
	<input type="text" value=" please select "/>		
2.	Age group *		
	<input type="radio"/> 25-34	<input type="radio"/> 35-44	<input type="radio"/> 45-54
		<input type="radio"/> 55-64	<input type="radio"/> 65+
3.	Academic degrees: Please indicate your most recent degree *		
	<input type="text" value=" please select "/>		
4.	Is the job from which you have the experience regarding investment appraisal grouped with, or classified as a <u>Finance function</u>? *		
	<input type="radio"/> Yes	<input type="radio"/> No	
5.	Do you own shares or stock options in the company you are working for (with respect to your investment decision making)? *		
	<input type="radio"/> Yes	<input type="radio"/> No	
Back		This survey has been created by '2ask'	Next

B - Investment decisions in practice

6. Which of these methods do you choose for the financial appraisal of an investment project? *

Multiple selection possible.

- ☐ Payback
- ☐ Discounted payback
- ☐ Net present value (NPV)
- ☐ Internal rate of return (IRR)
- ☐ Real options
- ☐ Hurdle rate
- ☐ Return on investment or assets (ROI or ROA)
- ☐ Profitability index (PI)

7. Looking at past cash flow forecasts you made, would you say they were typically... *

Please indicate - with the benefit of hindsight - which way your forecasts have been trending. Did your estimates tend to be more careful or more bullish in the past?

- | | | | | | | |
|-----------------------|-----------------------|-------------------------|------------------------|------------------------|-----------------------|-----------------------|
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| very
downbeat | pessimistic | a little
pessimistic | accurate on
average | a little
optimistic | optimistic | very upbeat |

8. How do you determine the discount rate for appraising an investment project? *

- ☐ I use the same discount rate for all projects (standard rate)
- ☐ I use a base discount rate and may increase it by some points to allow for particular uncertainty of a given project
- ☐ I calculate an individual discount rate for each potential new investment
- ☐ I don't use discounting methods
- ☐ Other - please specify

9. "Prior to making an investment decision, I require putting in a lot of research and analysis to reduce uncertainty as much as possible." *

Please indicate to what extent you agree with this statement.

- ☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

10. Have you ever accepted an investment project which had been forecast to have a negative net present value (NPV), and why? *

- ☐ No, never - I always respect the NPV rule
- ☐ No, because I don't use NPV as a criterion
- ☐ Yes, because I had no trust in the figures
- ☐ Yes, and my reason was:

11. When would you reject an investment that was forecast to have a positive NPV? *

Some projects may be competing with other projects, i.e. they are mutually exclusive. Please disregard such cases for responding to this question.

☐ Never; all non-mutually exclusive projects with a positive NPV are accepted

☐ If investing in the project meant using external finance (absence of internal free cash flow)

☐ Only if all sources of funding are depleted

☐ I don't use the NPV technique

☐ Other - please specify

12. The factors that make a project turn out profitable, once it was accepted, are partly controllable and partly down to luck (uncontrollable).

How much would you say is - on average - down to luck (beyond control)? *

Please indicate the percentage which is beyond control by clicking on the scale below.

[%]
nothing
down
to luck

0

50

100

[%]
everything
depends
on luck

13. Did you ever keep investing - at least for some time - in a project where immediate (early) abandonment would have been cheaper than continuation? *

☐ Yes

☐ No

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Organizer: School of Management, Claverton Down, BA2 7AY Bath, Großbritannien, c.klauss@bath.ac.uk

C - Your opinion on selected aspects of investing

14. "My aim is that every investment I promote or select will increase shareholder value." *

- ☐ Strongly disagree
 ☐ Disagree
 ☐ Neither agree nor disagree
 ☐ Agree
 ☐ Strongly agree

15. "The effort I dedicate to an investment project always significantly increases its chances of success." *

- ☐ Strongly disagree
 ☐ Disagree
 ☐ Neither agree nor disagree
 ☐ Agree
 ☐ Strongly agree

16. Please estimate 80%-confidence intervals. The LOW and HIGH values are boundaries to a range of values for which you are 80% certain that it contains the true value. *

Please note that you are NOT asked to research the exact values. Simply estimate the HIGH and LOW boundaries such that you believe that there is only a 20% risk that the true value does not lie within your chosen interval.

	LOW	HIGH
How many shares of Adidas Salomon AG were traded on the German DAX stock index on 1st Oct 2003?	<input type="text"/>	<input type="text"/>
How many cars did BMW AG sell in total (incl. BMW, Mini & Rolls Royce) in the first quarter of 2004?	<input type="text"/>	<input type="text"/>
How many SHELL petrol stations were there in Germany as of July 2003?	<input type="text"/>	<input type="text"/>
How many employees outside of Germany did Deutsche Bank AG have as on 1st Jan 2004?	<input type="text"/>	<input type="text"/>
How many medical doctors (excluding dentists) were there in Germany as of Dec. 2003?	<input type="text"/>	<input type="text"/>

17. Please indicate how you would rate the prospects of your company [compared to its competitors, for the medium to long term]: *

Very bad Far below average Slightly below average About average Slightly better than average Far better than average Superb

18. "It seems to me that in the stockmarket, my company's shares are most of the time..." *

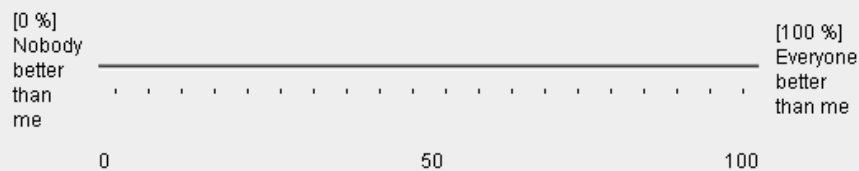
☐ strongly undervalued ☐ undervalued ☐ a little undervalued ☐ fairly priced ☐ a little overvalued ☐ overvalued ☐ strongly overvalued

19. "My experience at making investment decisions is..." *

☐ very low ☐ low ☐ below average ☐ average ☐ above average ☐ high ☐ very high

20 In comparison to other managers at your level, doing a similar job (inside and outside your company), what percentage would you estimate to have better skills and ability than you? *

Please click on the scale.



21. How much would you regret not having chosen an investment that subsequently turns out to be **very profitable**? *
Please click on thermometer.



22. How much would you regret having chosen an investment that subsequently turns out to be **loss-making**? *
Please click on thermometer.



23. "The **regret** about having undertaken a project that subsequently turned out to be loss-making is greatest once the project is terminated, and the total loss is realised." *

- ☐ Strongly disagree
 ☐ Disagree
 ☐ Neither agree nor disagree
 ☐ Agree
 ☐ Strongly agree

24. Which of the following statements best reflects your overall approach to investment decisions? *

- ☐ Time and effort are very costly. Once a proposed investment meets my requirements (e.g. positive NPV, profitability level), I do not continue to search for a potentially even better investment that may exist.
- ☐ I devote considerable effort to making sure I can compare as many acceptable projects as possible so that I can select only the best.
- ☐ None of the above.

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APPENDIX E: INSTRUCTIONS FOR EXPERIMENT 1 (PROJECT SELECTION AND EFFORT)

Procedure & set up

- 1) Skill & knowledge quiz
 - Multiple-choice pub quiz
 - Numerical problems
 - General knowledge estimates
 - ⇒
 - 2) Investment decision
 - Outcome / performance → prize
 - Outcome depends on
 - Skill & knowledge – from the quiz!
 - Your effort level – your choice!
 - Chance – good luck!
- Participation in this experiment and your performance are treated confidentially and will not affect your course evaluation.
 - A guided exercise:
 - Explanations as you move along
 - Don't proceed unless your told to
 - Time to finish: about 30 minutes

The quiz: 3 sections, 15 minutes (~1min/q)

Section 1: Multiple choice questions

1.1 By what name is the day of the London stock market crash in 1929 known?

- (a) Black Monday (b) Black Tuesday (c) Black Thursday (d) Black Friday

1.2 Which was the world's first credit card?

- (a) American Express (b) Visa (c) Master Card (d) Diners Club

1.3 How many stars does the flag of the European Union now have?

- (a) 10 - ten (b) 11 – eleven (c) 12 – twelve (d) 13 – thirteen

1.4 In which ski resort were the first Winter Olympics held?

- (a) St Moritz (b) Chamonix (c) Klosters (d) Val d'Isère

1.5 In which US state would you find the Everglades?

- (a) Colorado (b) Florida (c) Nevada (d) Utah

1.6 Which driver won the Formula One British Grand Prix in 1999?

- (a) Ralf Schumacher (b) Eddie Irvine (c) David Coulthard (d) Mika Hakkinen

1.7 Who was the youngest president of the United States?

- (a) William J. Clinton (b) John F. Kennedy (c) Harry S. Truman (d) Theodore Roosevelt

The quiz - continued

Section 2: Numerical multiple choice problems

2.1 Please only ESTIMATE the answer – no need to calculate. Out of the four options, choose the one nearest to your estimate.

Estimate the solution for: **76% of 15,605 = ?**

- ☆ (a) 12,880 (b) 11,860 (c) 11,040 (d) 10,180

2.2 A maintenance contract costs \$87 per month, and a technician call-out when not under a maintenance contract is priced at \$325.

How many call-outs per year would make the maintenance contract worthwhile?

- ☆ (a) 2 (b) 3 (c) 4 (d) 5

2.3 Solve $9 - 6\frac{1}{4} = ?$

- ☆ (a) 4 (b) 3.25 (c) 3.75 (d) 2.75

The quiz

Section 3: Estimating an unknown number

For these final questions, you don't need to know the precise answer. Rather, your task is to make estimates for a value range for which you feel 80% confident that it contains the correct answer. In other words, your estimated range should only be too narrow in 20% of the cases.

	→ 80% Confidence intervals	LOW / MIN	HIGH / MAX
3.1	In which year was Isaac Newton born?		
3.2	How many members does OPEC have?		
3.3	From which year dates Alexander G. Bell's patent for the telephone?		
3.4	How tall is the Sears Tower (excl. antenna, in ft or meters)?		
3.5	How many founding members does the UN have?		
3.6	How many joints are there in the human body?		
3.7	What is the average distance (from Earth) to the moon (mil. or km)?		
3.8	How many medical doctors are there in Germany (31-Dec-2004)?		
3.9	How many cars did BMW Group sell in the first 3 months of 2005?		
3.10	In how many countries do people drive on the left-hand side of the road?		

The quiz - completed

- Well-done – you have completed the first part of this experiment
- Finally, please complete the self-evaluation questions below


4.1 How many questions do you think you answered correctly in this quiz?
<input type="checkbox"/> less than 10% <input type="checkbox"/> around 25% <input type="checkbox"/> about half <input type="checkbox"/> about 75% <input type="checkbox"/> over 75%
4.2 How do you think you performed in comparison to the other participants?
<input type="checkbox"/> far below average <input type="checkbox"/> below average <input type="checkbox"/> average <input type="checkbox"/> above average <input type="checkbox"/> far above average
4.3 Which choice option would you prefer?
<input type="checkbox"/> 500 pounds for sure OR <input type="checkbox"/> 45% chance of winning 1,000 and nothing otherwise
4.4 Which of these two options would you prefer?
<input type="checkbox"/> 500 pounds for sure OR <input type="checkbox"/> 55% chance of winning 1,000 and nothing otherwise
4.5 Please indicate your gender & username :
<input type="checkbox"/> MALE <input type="checkbox"/> FEMALE


- ☛ **Have you completed all questions? – This is important for your data to be useable in our research.**

The investment decision

- You are a corporate finance manager: Decide how many projects you want to invest in. You have a budget of \$1,000.
- You don't have to invest at all, but investing could make you richer.
- Each project costs \$200 (a one-off investment)
- The outcome of the investment depends on the 'state of nature' in the next time period. Under the good state, your investment adds value.
- The probability for the good 'state of nature' is affected by your actual performance in the quiz, and whether you choose to 'exert effort'
- Effort comes at a cost: Pay \$200 to receive better success probabilities

Decision sheet

Your EFFORT choice (Tick one box only)		Category, depending on your quiz performance	Probabilities for States of Nature	
			Good state	Bad state
<input type="checkbox"/>	NO Effort	Top 25% + no effort	0.50	0.50
		Other 75% + no effort	0.33	0.67
<input type="checkbox"/>	EFFORT - yes	Top 25% WITH effort	0.83	0.17
	→ cost = 200	Other 75% WITH effort	0.50	0.50

Your INVESTMENT choice (Tick one box only)		Required investment	NPV values	
			HIGH (Good state)	LOW (Bad state)
<input type="checkbox"/>	0 – no investment	0	0	0
<input type="checkbox"/>	1 – one project	200	200	-300
<input type="checkbox"/>	2 – two projects	400	400	-600
<input type="checkbox"/>	3 – three projects	600	600	-900
<input type="checkbox"/>	4 – four projects	800	800	-1,200
<input type="checkbox"/>	5* – five projects (*) possible only if no effort expenses made	1,000	1,000	-1,500

APPENDIX F: INSTRUCTIONS FOR EXPERIMENT 2 (PROJECT EVALUATION)

Instructions for treatment group

① About yourself

Your performance in this experiment does not affect your course evaluation. Your responses are treated with strict confidentiality so that at no time individual identities will be revealed.

In order to contact you regarding your pay-out from the experiment, however, I will need to know your Bath username.

☞ _____@bath.ac.uk

☞ Gender: ☐ Female ☐ Male

② Choice between gambles

Consider the following two gambles:

A
35% chance of winning £130
65% chance of winning nothing

B
65% chance of winning £70
35% chance of winning nothing

☞ Which would you prefer?

- ☐ A
☐ B
☐ No preference

③ Evaluation decision

- Assume you are a corporate finance manager in a well-run medium-size company
- However, there is one investment project which has serious problems; in fact, things are so bad that the CEO has asked you to think about whether the project should not be abandoned immediately – after all, it was you who initially assessed the proposal and recommended to start investing in this particular project.
- These are your options:

(a) Abandon: If abandoned today, the project will have cost the company a net amount of £200,000. However, some cash may be recovered if you find someone to buy the existing assets related to the project. You think that there is a 50% chance that this will happen; in that case, the assets should sell for £80,000.

(b) Continue: You estimate that there is a 20% chance that – due to changed market conditions – the project may break even in 6 months time. To keep the project going until then would require you to make a further investment of £5,000. On the downside, if market conditions do not improve (likelihood of 80%), your total loss would then be £205,000.

The table below summarizes these probabilities and outcomes:

Decision	Probability	Outcome
abandon	0.5	-£120,000
	0.5	-£200,000
continue	0.2	0
	0.8	-£205,000

IMPORTANT:

- If you decide to abandon the investment project, the eventual outcome will be visible to you and your CEO. In addition, the outcome you could have obtained under continuation will also be visible, i.e. the market conditions will be known to you and your CEO (full outcome resolution).
- If you choose to continue the investment, you and your boss will only find out that particular outcome, i.e. how the market developed, but no-one will know what you could have had had you abandoned the investment project instead.

☞ What do you decide to do?

- ☐ Abandon the investment immediately
- ☐ Continue with the investment

④ Finally – why?

Please explain very briefly your main reason(s) for making this decision, hence what made you choose to continue or to abandon the investment project.

☞ Your reason(s)

**PLEASE ENSURE THAT YOU HAVE COMPLETED ALL SECTIONS.
THANK YOU VERY MUCH FOR TAKING PART IN THIS EXPERIMENT!**

Instructions for control group

① About yourself

Your performance in this experiment does not affect your course evaluation. Your responses are treated with strict confidentiality so that at no time individual identities will be revealed.

In order to contact you regarding your pay-out from the experiment, however, I will need to know your Bath username.

☞ _____@bath.ac.uk

☞ Gender: ☐ Female ☐ Male

② Choice between gambles

Consider the following two gambles:

A
35% chance of winning £130
65% chance of winning nothing

B
65% chance of winning £70
35% chance of winning nothing

☞ Which would you prefer?

- ☐ A
☐ B
☐ No preference

③ Evaluation decision

- Assume you are a corporate finance manager in a well-run medium-size company
- However, there is one investment project which has serious problems; in fact, things are so bad that the CEO has asked you to think about whether the project should not be abandoned immediately – after all, it was you who initially assessed the proposal and recommended to start investing in this particular project.
- These are your options:

(a) Abandon: If abandoned today, the project will have cost the company a net amount of £200,000. However, some cash may be recovered if you find someone to buy the existing assets related to the project. You think that there is a 50% chance that this will happen; in that case, the assets should sell for £80,000.

(b) Continue: You estimate that there is a 20% chance that – due to changed market conditions – the project may break even in 6 months time. To keep the project going until then would require you to make a further investment of £5,000. On the downside, if market conditions do not improve (likelihood of 80%), your total loss would then be £205,000.

The table below summarizes these probabilities and outcomes:

Decision	Probability	Outcome
abandon	0.5	-£120,000
	0.5	-£200,000
continue	0.2	0
	0.8	-£205,000

IMPORTANT

- Whichever decision you take (abandon or continue), only the outcome of your chosen decision will eventually be visible to you and your CEO. In other words, no-one will ever know what would have happened had you taken a different decision instead.

☞ What do you decide to do?

- ☐ Abandon the investment immediately
- ☐ Continue with the investment

④ Finally – why?

Please explain very briefly your main reason(s) for making this decision, hence what made you choose to continue or to abandon the investment project.

☞ Your reasons

**PLEASE ENSURE THAT YOU HAVE COMPLETED ALL SECTIONS.
THANK YOU VERY MUCH FOR TAKING PART IN THIS EXPERIMENT!**

APPENDIX G: ALTERNATIVE PROJECT EVALUATION EXPERIMENT (PROPOSED OUTLINE)

The basic set-up of this experiment follows Zanibbi & Pike (1996) in that subjects receive information about several different investment projects. However, there is considerable uncertainty about the final pay-off from each investment if it is continued: This uncertainty is induced following Heath (1996): There are two probability distributions but subjects do not know which one will materialize for which investment. Subjects only know the pay-offs under the good and bad states of nature, and the two probability distributions. Based on this information, subjects need to decide whether to abandon or to continue each single project.

The proposed sequence of events is thus as follows.

- Subjects' risk preferences are established in a simple gamble. This is necessary to distinguish later on between risk-averse and regret-averse behaviour.
- Subjects receive the instructions and are told that there is a reward for the top (in terms of value maximization) 5 participants
- The treatment to induce regret aversion in one group may follow the proposed approach presented in Section 4.4.2 following Zeelenberg et al. (1996).
- Subjects receive a list of investments, detailing the termination value, as well as the pay-offs under the different states of the world. Given the prediction of my model that regret aversion should lead to early abandonment, the financial parameters of the presented investments should be such that even a moderately risk-averse but unbiased decision maker would choose to continue them.